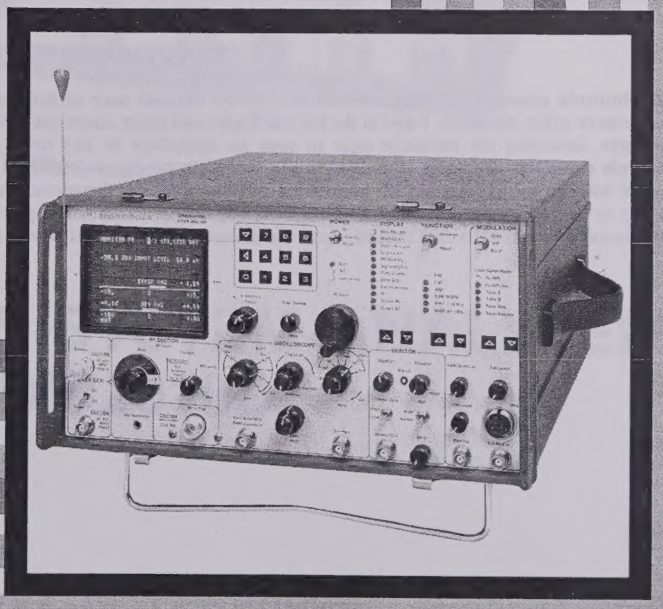
MOTOROLA INC.

test equipment

Communications System Analyzer OPERATOR'S MANUAL



R2008D/R2010D

68P81069A62-0

MOTOROLA TEST EQUIPMENT PRODUCTS
LIMITED WARRANTY
(EXCLUDES EXPORT SHIPMENTS)

Motorola Test Equipment Products (herein the "product") that are manufactured or distributed by Motorola Communications Group Parts Department are warranted by Motorola for a period of one (1) year from date of shipment against defects in material and workmanship.

This express warranty is extended to the original purchaser only. In the event of a defect, malfunction, or failure during the period of warranty, Motorola, at its option, will either repair, or replace the product providing that Motorola receives written notice specifying the nature of the defect during the period of warranty, and the defective product is returned to Motorola at 1313 East Algonquin Road, Schaumburg, IL 60196 transportation prepaid. Proof of purchase and evidence of date of shipment (packing list or invoice) must accompany the return of the defective product. Transportation charges for the return of the product to Purchaser shall be prepaid by Motorola.

This warranty is void, as determined in the reasonable judgement of Motorola, if:

(a) The product has not been operated in accordance with the procedures described in the operating instruction;

(b) The seals on non-user serviceable components or modules are broken;

(c) The product has been subject to misuse, abuse, damage, accident, negligence, repair or alteration.

In no event shall Motorola be liable for any special, incidental, or consequential damages.

In the event Motorola elects to repair a defective product by replacing a module or subassembly, Motorola, at its option, may replace such defective module or subassembly with a new or reconditioned replacement module or subassembly. Only the unexpired warranty of the warranty product will remain in force on the replacement module or subassembly. EXCEPT AS SPECIFICALLY SET FORTH HEREIN. ALL WARRANTIES EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, ARE EXCLUDED.

EPS-30828-O

SUPPORT SERVICES

For service on your Motorola test equipment in the U.S. contact the Test Equipment Service Center, Schaumburg, 1313 E. Algonquin Rd., Schaumburg, Illinois 60196 or call the Test Equipment Service Hotline: 800/323-6967 during normal business hours. In Illinois call 1-312-576-7025. Outside the U.S. contact your nearest Motorola representative.

MODULE EXCHANGE PROGRAM

Modular construction of the R2001 allows field replacement of individual assemblies. Contact the Test Equipment Service Center for pricing and delivery. Outside the U.S. contact your nearest Motorola representative.

COMPUTER SOFTWARE COPYRIGHTS

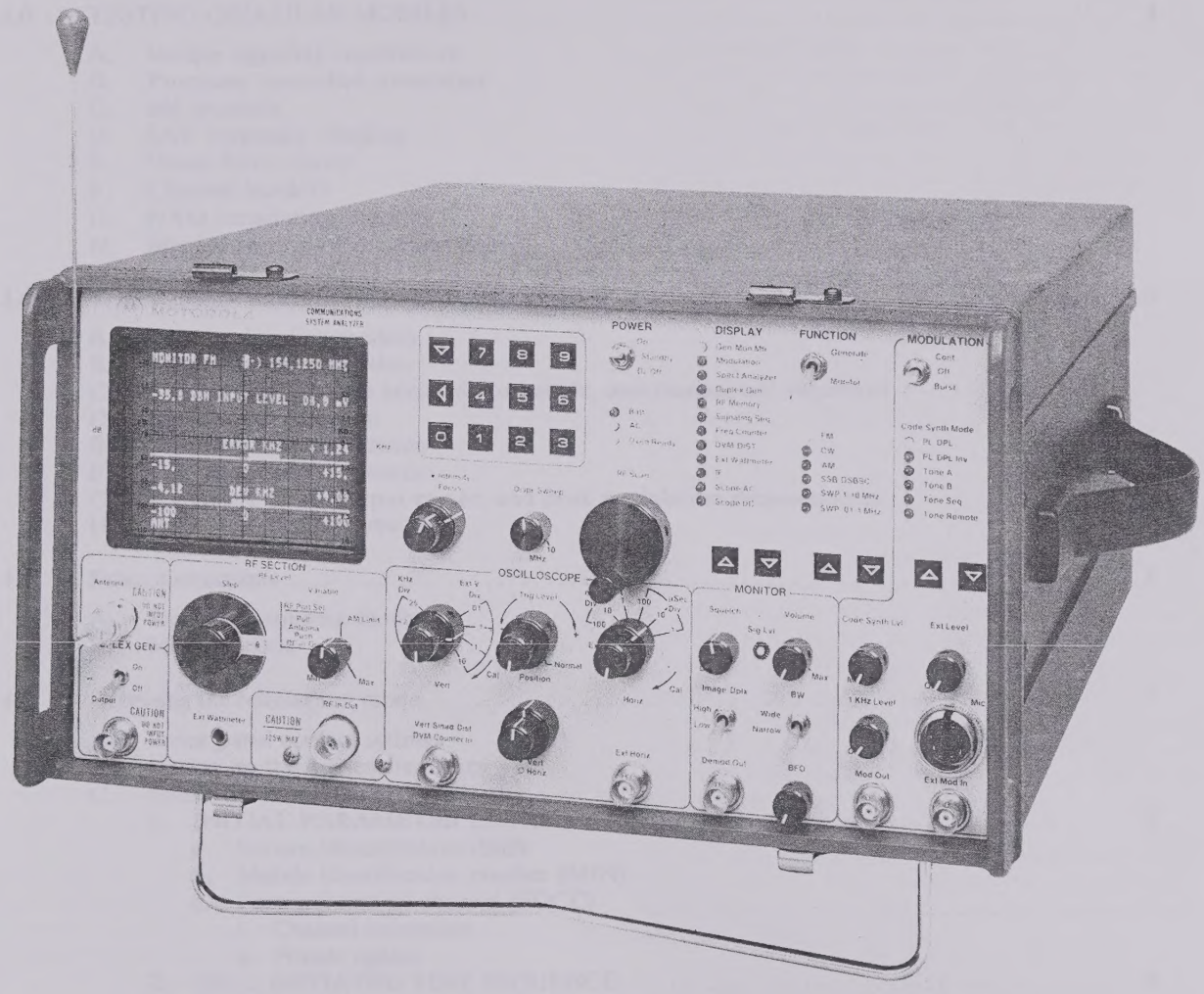
The Motorola products described in this instruction manual may include copyrighted Motorola computer programs stored in semiconductor memories or other mediums. Laws in the United States and other countries preserve for Motorola certain exclusive rights for copyrighted computer programs, including the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Motorola computer programs contained in the Motorola products described in this instruction manual may not be copied or reproduced in any manner without the express written permission of Motorola. Furthermore, the purchase of Motorola products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Motorola, except for the normal non-exclusive, royalty free license to use that arises by operation of law in the sale of a product.

EPS-34440-A

Specifications subject to change without notice.
Ⓜ, Motorola, Private-Line, and Digital Private-Line are trademarks of Motorola, Inc.
■ Printed in U.S.A. ■ ©1985 Motorola Inc.

MOTOROLA INC.

Communications Sector



COMMUNICATIONS SYSTEM ANALYZER
R2008D/R2010D

©Motorola, Inc. 1985
All Rights Reserved
Printed in U.S.A.

Motorola Test Equipment Products

1313 E. Algonquin Rd.
Schaumburg, IL 60196

68P81069A62-0
7/8/85-PHI

TABLE OF CONTENTS PAGE

1.0 INTRODUCTION 1

2.0 THE CELLULAR CONCEPT 1

3.0 TESTING CELLULAR MOBILES 4

A. Unique signaling requirement
B. Processor controlled transceiver
C. 666 channels
D. SAT frequency checking
E. Power level control
F. Channel handoff
G. NAM installation checking
H. Manual control of the transceiver

4.0 THE R2008D/R2010D TEST CAPABILITIES 4

A. Built-in signaling modem
B. Single channel operation
C. Cell initiated, mobile initiated, automatic, and manual test sequences
D. SAT tone verification
E. Signaling data verification
F. Test progression indicator
G. Frequency error, output power, and peak modulation measurements
H. Error detection and readout

4.1 Setup instructions 5

A. Signaling sequence mode
B. Manual mode

4.2 Accessing the cellular test mode 7

A. Front panel control settings
B. Setting up the duplex frequency
C. Selecting the cellular test mode
1. INITIAL PARAMETER ENTRY 7
a. System identification (SID)
b. Mobile identification number (MIN)
c. Forward control channel (FOCC)
i. Channel increment
ii. Printer option
2. CELL INITIATED TEST SEQUENCE 8
a. Call processing steps
b. Channel handoff
c. Power level tests
d. Modulation level tests
3. MOBILE INITIATED TEST SEQUENCE 10
a. Call processing steps
b. Channel handoff
c. Power level tests
d. Modulation level tests
e. Dialed telephone number
4. MANUAL TEST 11
a. Command Entry
b. Command List
i. Input and output descriptions
c. Examples of use
5. AUTOMATIC TEST SEQUENCE 13
a. Test initialization
b. Test output
c. Printer operation

5.0 APPLICATION NOTES

A. Receiver audio level testing 15
B. Transmitter deviation 15
C. Receiver sensitivity 15
D. Power level setting 16
E. Testing signaling at threshold level 16
F. Duplex sensitivity 18
G. SAT phase 19
H. RSSI level testing 21

APPENDICES

A. Cell Initiated Test Step Definition 22
B. Mobile Initiated Test Step Definition 24
C. Detailed Cell Initiated Test Actions 25
D. Detailed Mobile Initiated Test Actions 28
E. Warning and Error Messages 29
F. Manual Test Commands 33
G. Epson RX-80/LX-80 Printer Setup 37
H. U.K. Cellular System Analyzer (R2010D) differences 38

1.0 INTRODUCTION

The R2008D/R2010D is an expansion of the R2001D which extends its testing capability to include the unique requirements of cellular radio systems. Any existing R2001D communications system analyzer can be modified to an R2008D/R2010D. With the modification, all of the capability of the R2001D is retained with the cellular test sequences being added as an extension of the tone memory display.

Cellular test capability in the R2008D/R2010D includes performance verification for both the digital signaling and the RF transceiver aspects of the cellular radio. In the cellular test mode, the analyzer simulates the basic aspects of the central cell site. It provides all of the signaling required to allow both call origination and call reception testing on the cellular transceiver. In addition, once the voice path is established, the R2008D/R2010D can then be used to simulate cell site to cell site handoffs, to control the transmitter power level, and to execute performance tests normally associated with a transceiver.

A fully automatic test sequence is provided which sequences through an operator selectable number of the 666 cellular channels and measures the transmitter output power, frequency error, and modulation limiting for each channel. Provision has been made for attachment of a serial printer RS-232, (1200 baud) to provide hardcopy output of AUTOTEST MODE results. The printer can also print the contents of the CRT display in all modes except MODULATION, SPECTRUM ANALYZER, IF, AND SCOPE, by pressing both the left cursor key and the "0" key together.

To complete the package, the R2008D/R2010D also provides the interface to manually control the transceivers that are compatible with the Advanced Mobile Phone Service Cellular Mobile Telephone Equipment Specification, July 1983. This separate interface bypasses the normal RF signaling interface and allows direct control over transceiver functions such as channel selection, transmitter key, transmitter audio, and receiver audio. Also available through this interface is access to the number assignment module (NAM) and the nonvolatile memory (NVM). A total of 43 commands are available for the purpose of setting up, checking out, and troubleshooting the cellular radio.

This manual is written as a supplement to the R2001D Operator's Manual (68P81069A66); refer to the R2001D Operator's Manual for the operating instructions in non-cellular testing.

U.K. Cellular Test Capability. The United Kingdom (U.K.) Cellular System Analyzer (R2010D) is the basic R2008D analyzer with modifications to permit testing of U.K. "TACS" System Cellular Mobile Transceivers. A description of differences between the U.S. cellular system and the "TACS" system is found in appendix "H".

2.0 THE CELLULAR CONCEPT

Conventional VHF mobile telephone systems use a single transmitter site to cover a given service area. A cellular mobile telephone system, on the other hand, divides the service area into smaller coverage areas called cells. A cellular system consists of a continuous pattern of these hexagon-shaped cells, each having a 5 to 10 mile radius. Within each cell is a centralized based station which contains transceivers and related control equipment for the channels assigned to that cell. All of the cells within a system are then connected either by dedicated land lines, microwave links, or a combination of both to a central control site. The central control site, or controller, is responsible for the overall control of the system and the interface to the land line network.

A cellular radio-telephone in the cell system is under the indirect control of the central controller. A series of control channels over which only digital signaling is allowed and voice channels which allow both audio and signaling are used for control and data transfer as well as for conversation once the call is established. The control channels are divided into three groups: Forward control, paging, and access channels. The control channel generally provides some basic information about the particular cellular system such as the system identification number and the range of channels to scan to find the paging and access channels. Paging channels are the normal holding place for the idle cellular radio. When a call is received at the central controller for a cellular radio, the paging signaling will occur on a paging channel. In responding to a page or when originating a call, the radio telephone will use an access channel where two way data transfer occurs to determine the initial voice channel. In many systems all three control channel functions will be served by the same channel for a particular cell. The R2008D/R2010D operates in this single data control channel mode. Only in the very high density areas will multiple channels be required.

Voice channels are primarily used for conversation with signaling being employed as necessary to effect cell to cell handoffs, output power control on the cellular radio and special local control features. Data from the cell site, forward data, and data from the mobile, reverse data, is sent at a 10 kilobit/second rate utilizing direct frequency modulation. The data is formatted into groups of words with a distinct binary preamble that allows the receiver to synchronize to the incoming data.

In addition to the digital signaling there are two tone signaling mechanisms employed in the cell system. The supervisory is one of three frequencies around 6 kilohertz. It is generated by the cell site, checked for frequency by the cellular radio, and then transponded back to the cell site on the reverse channel. The cellular radio uses the SAT to verify that it tuned to the correct channel after a new voice channel command. When the central controller signals the mobile

regarding a new voice channel, it also informs the mobile of the SAT frequency to be expecting on the new channel. The returned SAT signal is used at the cell site to verify the presence of the radio-telephone on the designated channel and to determine the signal strength of the cellular radio's RF carrier. A separate 10 kilohertz tone is utilized by the mobile on the reverse channel to acknowledge various commands from the cell site.

When first turned on, the cellular radio-telephone will scan through the nationwide set of forward control channels and measure the signal strength on each one. It will then tune to the strongest one and receive the overhead control message. From the overhead message, the radio will be able to determine whether or not it is in its home system, and the range of channels to scan for paging and access. Radios not in their home system will be able to use other cellular phone systems depending on the level of service requested by the user. The radio next scans each paging channel in the specified range and tunes to the strongest one. On that channel the radio continuously receives the overhead message information plus paging messages. At this point the radio idles, continuously updating the overhead message information in its memory and monitoring the paging messages for its phone number. When a page match occurs, the radio scans each of the channels designated as access channels and tunes to the strongest one.

On the access channel the radio acknowledges the page and thus notifies the central controller of its cell location. The controller then assigns a voice channel and a SAT code to the radio. Upon reception of the voice channel command the radio tunes to the voice channel, verifies the presence of the proper SAT frequency and transponds the tone back to the cell site. At the cell site, the reception of the SAT tone signals the central controller that the radio is ready for the call. An alert order is then sent to the radio which responds with a 10 KHz signaling tone. The subscriber unit rings for 65 seconds or until the user answers. Then the 10 KHz signaling tone is terminated to alert the central controller that the user has answered. The central controller then connects the incoming call to the appropriate circuit leading to the cell in contact with the radio.

As the call progresses, the cell site continuously monitors the reverse channel for signal strength. Transmitter power commands will be sent to the cellular radio as required to maintain the received signal level within prescribed limits. This is done to minimize interference possibilities within the frequency reuse scheme. If the mobile is at its maximum allowed power for the cell that it is within and the received signal at the cell is approaching the minimum allowable, the cell will signal the central controller. The central controller will in turn have a scanning receiver at each of the surrounding cell sites measure the receive signal strength. The site with the strongest signal will be the site to which the call will be handed off. The handoff and transmitter power level changes are executed by interrupting the conversation with a burst of data containing the command. The radio acknowledges the order by a data burst in the case of a power control order, or by a burst of 10 kilohertz signaling tone in the case of a handoff. It should be noted that this data exchange happens very quickly and is hardly noticed by the user.

When the call is terminated by the party calling the cellular radio, the central controller issues a release order to the radio which acknowledges with a 10 kilohertz signaling tone burst and the cellular radio ceases transmission. If the call was terminated by the user of the cellular radio, the signaling tone burst signals the central controller which terminates the connection. In either case after call termination, the cellular radio goes back to rescan the nationwide set of forward control channels and repeats the process it performed at first turn on to re-establish itself on a paging channel.

When the call originates at the cellular radio, the radio scans the access channels and tunes to the strongest one. On that channel then the radio notifies the central controller of its identity and the number it wants to be connected to. From that point the process by which the cellular radio is assigned a voice channel and the call completed is the same as previously described.

Figure 1 provides a frequency spectrum overview for the domestic cellular system.

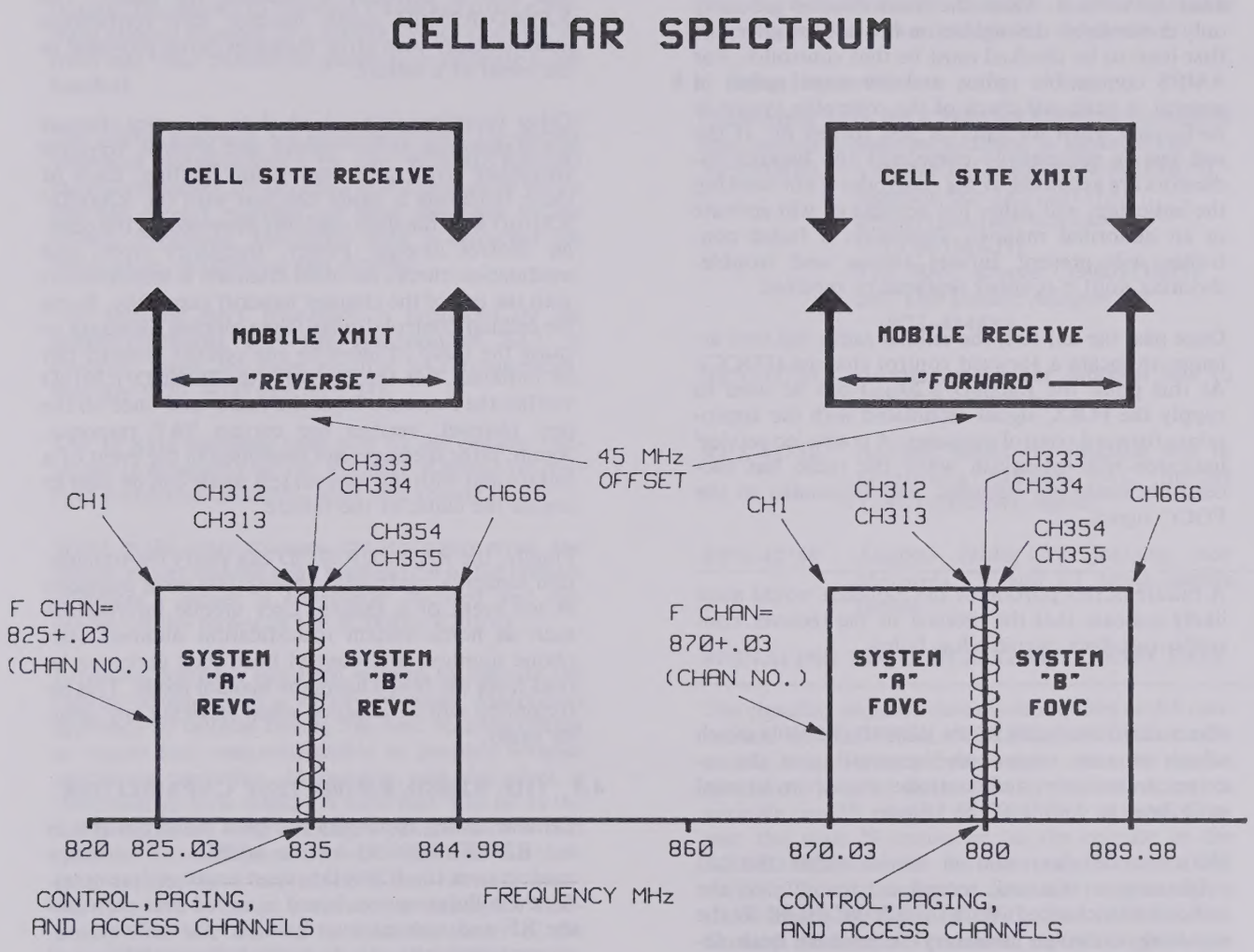

CELLULAR SPECTRUM
CELL SITE RECEIVE
CELL SITE XMIT
MOBILE XMIT
"REVERSE"
MOBILE RECEIVE
"FORWARD"
45 MHz
OFFSET
CH1
CH312
CH313
CH333
CH334
CH354
CH355
CH666
F CHAN=
825+.03
(CHAN NO.)
SYSTEM
"A"
REVC
SYSTEM
"B"
REVC
F CHAN=
870+.03
(CHAN NO.)
SYSTEM
"A"
FOVC
SYSTEM
"B"
FOVC
820
825.03
835
844.98
860
870.03
880
889.98
CONTROL, PAGING,
AND ACCESS CHANNELS
FREQUENCY MHz
CONTROL, PAGING,
AND ACCESS CHANNELS

FIGURE 1.

3.0 TESTING CELLULAR RADIOS

To ensure satisfactory operation of the cellular radio, the proper operation of the digital and analog signaling functions, the transceiver function, the transceiver control function, and the information contained in the Number Assignment Module (NAM) must be verified. Since the transceiver is generally only controllable through an on-board controller, the first item to be checked must be that controller. For AMPS compatible radios and for most radios in general, a basic self check of the controller system is performed when the radio is first turned on. If the self test is successfully completed the handset indicators are activated. If the controller is not working the indicators will either not activate or will activate in an abnormal manner. Generally, a failed controller will prevent further testing and troubleshooting until it is either replaced or repaired.

Once past the self test, the cellular radio will then attempt to locate a forward control channel (FOCC). At this point the R2008D/R2010D can be used to supply the FOCC signal modulated with the appropriate forward control messages. A cradle 'no service' indicator will extinguish when the radio has successfully tuned to, decoded, and responded to the FOCC signal.

A failure at this portion of the sequence would most likely indicate that the receiver or the receiver/controller interface circuitry has failed.

The manual test mode of the R2008D/R2010D which allows separate control and monitoring of the receiver, transmitter, and controller status can be used to isolate the source of the failure.

With the cellular radio in service either the call origination or the call reception capability of the radio can be checked. With the R2008D/R2010D the signaling exchange necessary to execute both sequences can be generated with the proper responses automatically checked for accuracy. Error messages are provided in the event that the radio does not respond properly. These messages and the manual test capability can then be used to isolate the cause of the failure.

Failure at this point would most likely be in the transmitter or data generating circuitry as the receiving circuitry had to be working to get an 'in service' indication.

A successful call origination or call reception test will end with the radio on a voice channel. On the voice channel the radio detects and checks for the correct SAT frequency, and then transponds the SAT signal on the reverse voice channel. It is necessary to verify that the radio correctly identifies the SAT frequency and that it correctly transponds the signal. The R2008D/R2010D again handles this verification automatically with error messages being provided in the event of a failure.

Other functions to be checked on the voice channel are transmitter power output and control, transmit frequency error, and modulation limiting. Each of these functions is easily checked with the R2008D/R2010D with the data readouts provided on the cellular control display. Power, frequency error, and modulation checks on other channels is implemented with the use of the channel handoff capability. From the cellular control display, the signaling necessary to cause the radio to move to any cellular channel can be initiated. For the handoff, the R2008D/R2010D verifies the response from the radio, and once on the new channel, verifies the correct SAT response. Again, error messages are generated in the event of a failure and with the manual test mode can be used to isolate the cause of the failure.

Finally, the R2008D/R2010D can verify the termination sequence again with appropriate error messages in the event of a failure. User unique information such as home system identification number, telephone number, and control head lock code can be read from the NAM using the manual mode. This information will be required when servicing any cellular radio.

4.0 THE R2008D/R2010D TEST CAPABILITIES

Cellular testing capability has been made possible in the R2008D/R2010D by the addition of one new module over the R2001D system analyzer (see note). A new cellular option board is added that performs the RF and manual interfacing to the cellular telephone transceiver unit. It controls the modulation of digital messages, audio and SAT tones by using the microprocessor to command the cellular radio.

The cellular option board also decodes the digital messages returned by the cellular telephone. This includes synchronizing on the dotting sequence and the word sync sequences at the start of these messages and decoding the Manchester encoded data in the message stream. The recovered digital information is then sent to the microprocessor board for processing. The cellular board also detects the presence of the 10 KHz tone sent by the cellular telephone, and can measure its duration. It does the necessary routing of SAT tones and audio.

Although the R2008D/R2010D can transmit only one frequency at a time, it can switch frequencies at a relatively fast rate, making it ideal for multiple frequency checks necessary for more complete cellular testing. Once the desired channel numbers are selected in the initial parameters screen, the R2008D/R2010D automatically switches its transmit and receive frequencies to simulate transition from a forward control channel to a forward voice channel, or from one voice channel to another, to simulate a cell handoff.

The digital messages are modulated onto the duplex generator automatically by the R2008D/R2010D Digital responses are decoded and analyzed to verify that the correct message has been sent back by the cellular telephone. Necessary data is extracted for verification, processing and display.

The required SAT frequency is produced by the R2008D/R2010D and the transponded SAT is checked. There are three possible SAT frequencies, they are 5970, 6000 and 6030 Hz.

The 10 KHz signaling tone sent by the cellular telephone is measured by the R2008D/R2010D to confirm successful handoffs, alert and release.

While in the voice channel, the frequency error, the output power and the peak modulation of the cellular telephone's carrier is constantly updated and displayed on the screen of the R2008D/R2010D.

Extensive software has been written to exercise the cellular telephone in a variety of ways. Motorola's approach to cellular testing has been to keep testing as simple and comprehendable as possible without sacrificing capability. In keeping with this ideal, a thermometer style display is used that 'fills in' as the test progresses. Help messages can be shown that spell out the definition of each square in the thermometer display. If a problem is encountered, warning and error message numbers are displayed. Temporary exits are allowed so that the power of the other R2008D/R2010D modes can be utilized.

The software version numbers for the 9 files that comprise the R2008D/R2010D software can be seen if a zero key is held down while the R2008D/R2010D is turned on. This version number display will stay on the screen for 10 seconds; then normal operation ensues.

A manual test mode allows the operator to command the cellular telephone with any one of the 43 commands defined by the Advanced Mobile Phone Service (AMPS) specification of May, 1983.

The following sections describe how to physically set up a test, using the RF interconnect or the manual test interconnect. Then, operator instructions on how to use the cell initiated test, the mobile initiated test, and the manual test are detailed. A list of possible warnings and errors is included in Appendix E.

4.1 Setup Instructions

Connection from the R2008D/R2010D to the mobile unit require accessories included in separate kits.

RPX-4350A - Variable RF coupler (58-80313B37)
Junction box (RTL-4137A)
Printer/junction box cable (01-80356A73)
TNC-BNC adapter (58-80313B33)
Self Test Enable Adapter (RTL-4148A)

RPX-4272A - Adapter cables for junction box to AMPS type radios

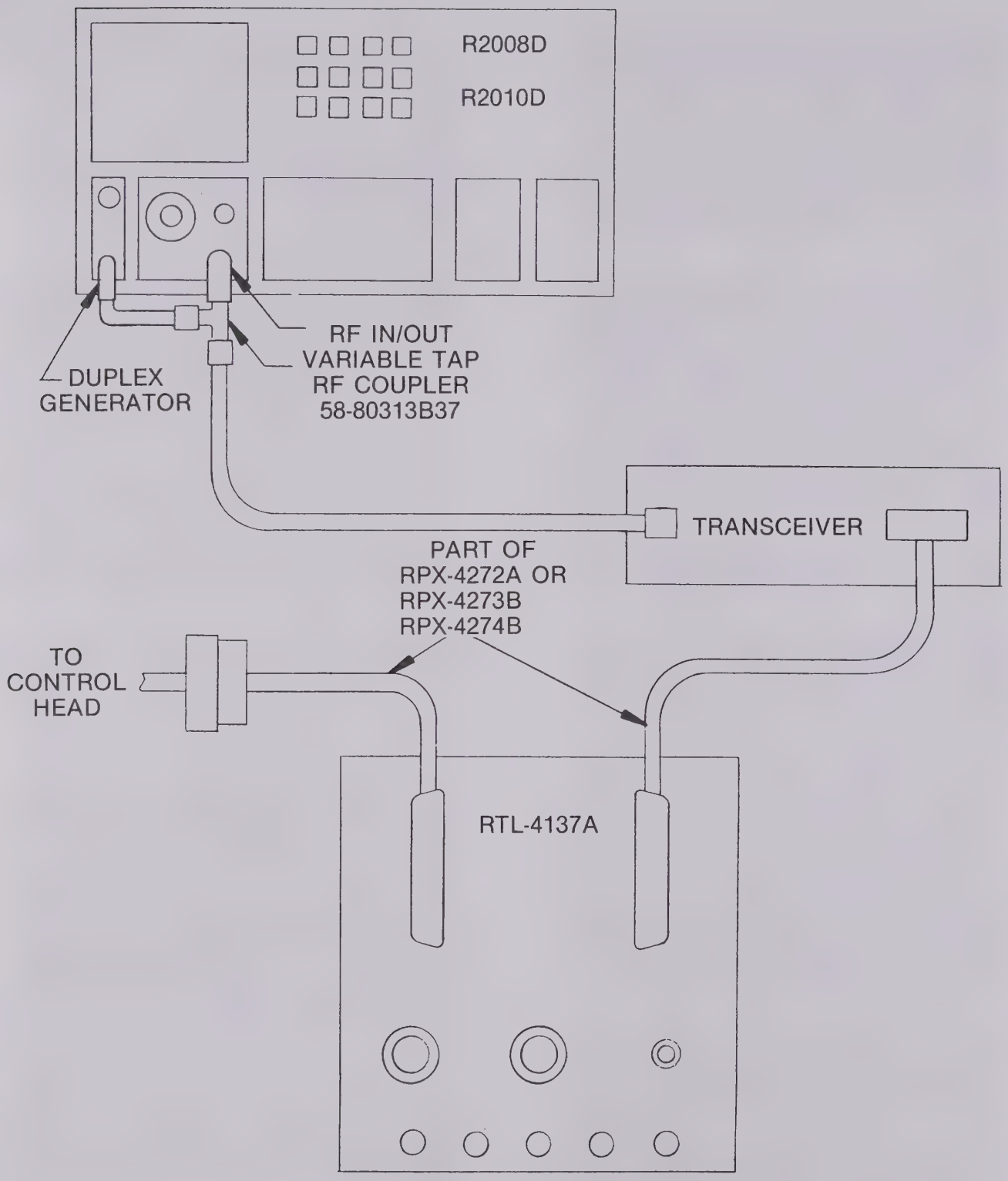
RPX-4273B - Adapter cables for junction box to Motorola DYNA-TAC model T19ATA8822AE radios.

RPX-4274B - Adapter cables for junction box Motorola CT and ET series mobile radios.

SIGNALING SEQUENCE TEST CONNECTION

The signaling sequence test mode requires an RF connection be made from the R2008D/R2010D to the mobile unit. To couple the output from the duplex generator to the main RF in/out connector, a variable tap RF coupler 58-80313B37, is used. Connect the male N connector on the coupler to the R2008D/R2010D RF in/out port. Connect the variable tap to the duplex generator output with a short length of BNC to BNC coax 01-80352A02. Connect the female N connector on the coupler to the mobile unit antenna connector. A TNC and BNC adapter, 58-80313B33, may be required to connect to the mobile unit. See figure 2.

It is sometimes useful to access some test points on the control head to transceiver interface during the signaling test mode. This is accomplished by using the cellular junction box RTL-4137A and the adapter cables included in either RPX-4272A, RPX-4273B, or RPX-4274B.



SIGNALING CONNECTION
FROM R2008D/R2010D TO CELLULAR TRANSCEIVER

FIGURE 2.

4.2 Operating Instructions

Front panel selections for cellular testing

Before initiating cellular testing, make the following adjustments and switch selections on the R2008D/ R2010D front panel. They are . . .

1. Enter a 45 MHZ offset in the DUPLEX GEN screen.
2. Set the RF step attenuator to 50 dB.
3. Set the DISPLAY led to Signaling Sequence.
4. Set the FUNCTION switch to Monitor.
5. Set the MODULATION Cont/Off/Burst switch to Off.
6. Use the FM FUNCTION state.
7. Set the BW (BandWidth) switch to Wide.
8. Set the Image/Dplx switch to High.
9. Adjust the Squelch level to near threshold. (Turn counter-clockwise until the squelch light comes on, then back off a small amount).
10. Set the variable RF tap between 1/4 to 1/2 inch from maximum coupling.

THE CELLULAR TEST SCREENS

The cellular test is accessed via the Signaling Sequence display. Enter '8' in the 'mode sel' position to access the cellular test screens. See figure 3. There are now 5 sub-selections possible. Move the cursor down to the 'seq sel' position. The 5 selections possible are described in the following paragraphs.

```
SIGNALING SEQUENCE MODE SEL) 8
       ENTER 0 FOR MENU

CELLULAR              SEQ SEL) -


1) INITIAL PARAMETERS
2) SEQ TEST, CELL INITIATED
3) SEQ TEST, MOBILE INITIATED
4) MANUAL TEST MODE
5) AUTO TEST MODE
```

FIGURE 3.
SIGNALING SEQUENCE MODE DISPLAY

1) INITIAL PARAMETERS

This screen allows for the entry of basic parameters concerning the cellular telephone under test and selections the operator desires. See figure 4. Entries must be made here in order to use any of the cellular signaling sequence tests. Selections are stored in non-volatile memory and are saved even if the analyzer is powered down.

```
CELLULAR INIT PARAM      SEL) -
 1) EXIT


 SYSTEM ID) 00002
 MOBILE ID) 312 576 5444
 FOCC)  334
 FVC  1)001 2)225 3)450 4)666

            AUTO TEST

 FVC INCREMENT) 035
 PRINTER (YES=1,NO=0) 1
```

FIGURE 4. INITIAL PARAMETERS DISPLAY

SYSTEM ID: Enter the system ID of the cellular telephone under test. Entering a SID that does not match the one of the cellular telephones under test will force the telephone to go into the ROAM state. The SID is a 15 bit binary number entered in decimal.

MOBILE ID: Enter the telephone number of the cellular telephone under test. Entering the MIN that does not match that of the radio under test will prevent the cellular telephone from being called in the cell initiated test. The mobile initiated test will update this field.

FOCC: Enter the number of the desired control channel. Cellular radios scan channels 313 to 354. Those units configured for operation in a non-wireline carrier system consider channels in the range 313 to 333 as home data channels. Those units configured for operation in a wireline carrier system consider the range 334 to 354 as home channels. However, for test purposes, any channel from 1 to 666 may be entered. A channel selection of 334 will result in the transmitted frequency of 835.02 MHZ from the R2008D/ R2010D. This is derived from the equation below . . . (825.00 + .03 X (channel number) MHZ).

FVC 1-4: Enter the forward voice channels desired. These four channels will be used to simulate cell handoffs during the signaling sequence screens. Also, FVC 1 is used as the first channel in the Auto Test sequence.

2) SEQUENCE TEST, CELL INITIATED

The cell initiated sequence test is designed to test the calling sequence when the R2008D/R2010D (simulating the cell site) initiates a call to the cellular telephone. The necessary sequence of events includes sending from the R2008D/R2010D overhead messages, a paging message, an initial voice channel designation message, power level command messages and handoff messages. The testing also requires that the digital and signaling tone responses to these commands to be processed and checked.

To aid the operator in visually verifying the progression of the test is a thermometer style sequence display. It will fill in from left to right as the test progresses. Refer to Figure 5. Help messages are available describing each step in the calling sequence.

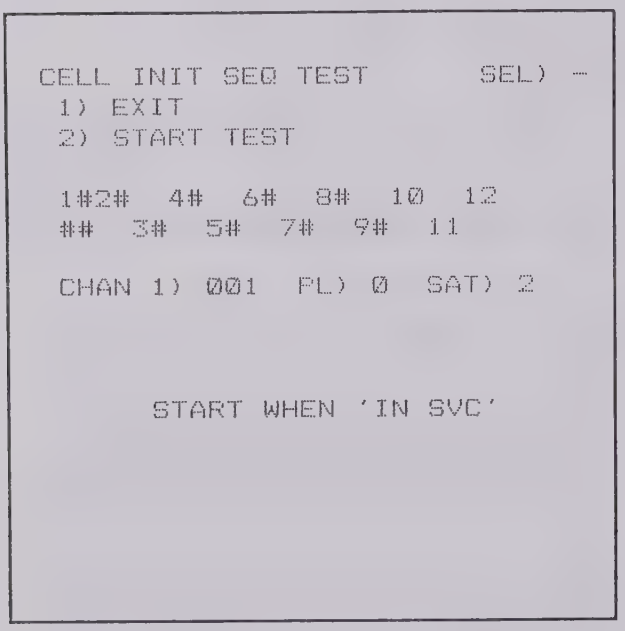


FIGURE 5.
CELL INITIATED SEQUENCE TEST DISPLAY

To view the help messages: Move the cursor underneath the squares of the thermometer and advance the cursor to the right by keying any number 1 to 9. The appropriate help message describing that step will appear. The squares on the top row of the thermometer display indicate actions that will be taken by the R2008D/R2010D during the test. The squares on the next line indicate actions that the mobile will take that are perceived by the R2008D/R2010D. Note that the first square is always filled since the R2008D/R2010D commences a FOCC data stream upon entry into the cell initiated sequence test screen.

The selections possible in the cell initiated test screen are 1) EXIT and 2) START TEST. These selections are possible if the cursor is in the home position at the top of the screen. A '1' will return the screen back to the Signaling Sequence screen. A '2' will start a sequence test.

If the cellular telephone is properly attached to the R2008D/R2010D, the no service light (NO SVC) on the cellular telephone will go out after the R2008D/R2010D has been in the cell initiated sequence test screen for about 5 seconds. This indicates that the cellular telephone has locked onto the FOCC data stream from the R2008D/R2010D. Visually verify that the no service light has gone out before starting the sequence test. Then enter a '2' after the 'SEL' to start the test.

The R2008D/R2010D will immediately start to execute the call sequence. As each step in the sequence is completed, the space above or below the square will 'fill in' in a thermometer style progression. If errors are detected, a warning will be displayed near the bottom of the screen if it is a non-fatal error, and an error message will be displayed if a fatal error. Upon starting the test, the R2008D/R2010D will send a paging message to the cellular telephone, if the phone number entered in the Initial Parameters screen matches the cellular telephone's number, the cellular telephone will respond with a page response message. The mobile ID and serial number will be extracted from this message. These values will be displayed as that message is successfully decoded.

Next, the R2008D/R2010D will issue an initial voice channel designation message, telling the cellular telephone which channel to switch to for voice communications. The R2008D/R2010D and the cellular telephone will now transmit on the forward voice channel (FVC) and the reverse voice channel (RVC), respectively.

The R2008D/R2010D now produces a Supervisory Audio Tone (SAT), which the cellular telephone is to transpond. The R2008D/R2010D will check this SAT for correct frequency. The R2008D/R2010D will then send an alert order, causing the cellular telephone to ring.

If the cellular telephone is answered at this point the test will progress into the conversation mode part of the sequence. However, the operator also has the option of using a temporary exit to look at waveforms while the cellular telephone is ringing (it will ring for 65 seconds if unanswered).

The selections possible in the conversation mode are displayed on the screen. See figure 6 for a pictorial representation of this screen. A frequency error, power level and a deviation indication will also appear at the bottom of the screen and will be updated continuously. Deviation values will typically be about 10 KHZ while the phone is ringing due to signaling tone modulation. Once answered, the signaling tone stops, and only SAT tone is transmitted. This produces a deviation of typically 2 KHz.

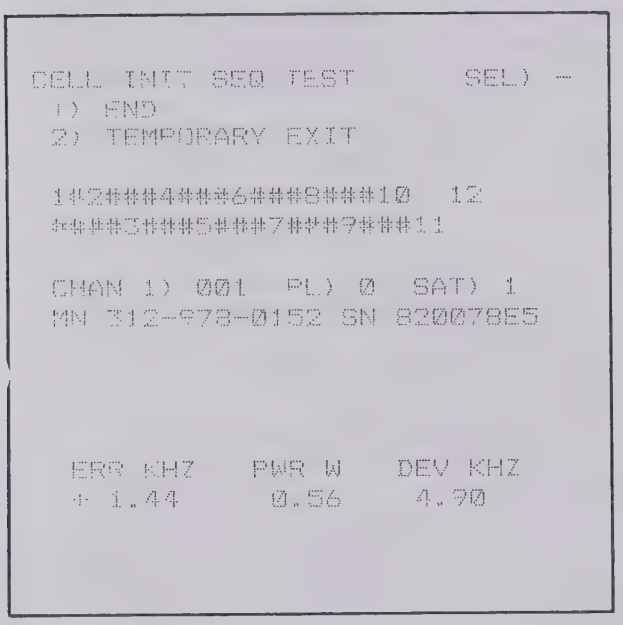


FIGURE 6.
CELL INITIATED TEST RESULTS DISPLAY

Move the cursor down and over to the 'PL' label and select power levels 0 to 7 to command the cellular telephone to any one of its 8 possible power levels. Key 0 is the highest power level and key 7 is the lowest power level. Pressing the key results in a power level order message being sent to the cellular telephone. An order confirmation will be sent back by the cellular telephone and checked by the R2008D/R2010D. The output power in watts measured at the R2008D/R2010D is shown at the bottom of the R2008D/R2010D screen (keep in mind that the BNC cable and connectors will attenuate the power level). A temporary exit can be performed to analyze the signal using the other R2008D/R2010D modes. Enter A '2' after the 'SEL' label to temporarily exit. Now use the display up/down buttons to move to the R2008D/R2010D's other test modes.

Do not linger in the spectrum analyzer mode, however, as this will terminate the duplex output and the cellular telephone will drop out after 5 seconds for want of a SAT tone.

When the display is returned to Signaling Sequence, the software will lock in on the sequence test again. Another power level command can be initiated, and again the operator can observe a change in the power output reading or do a temporary exit to analyze the signal.

Voice communication is possible. Turn up the monitor volume on the R2008D/R2010D and then talk into the handset of the cellular telephone. The operator should hear through the monitor speaker of the R2008D/R2010D. Attach the microphone supplied to the R2008D/R2010D MIC input and turn up the ext mod gain control. Key the microphone and talk into it. This should be heard in the handset of the cellular telephone.

To handoff to the forward voice channels defined in the Initial Parameters screen, position the cursor after the 'CHAN' label. Entries 1 to 4 are used to simulate moving from one cell area to another. To handoff to FVC #2, enter a '2' on the R2008D/R2010D. To handoff to FVC #4, enter a '4'. Handoffs can be performed as many times as desired, in any order. The 50 msec signaling tone response generated by the cellular telephone is measured for duration and an error message is shown on the R2008D/R2010D if out of limits. Every handoff will automatically rotate the supervisory audio tone (SAT). Handoffs to the same FVC will result in a new SAT tone only.

A SAT drop test can be performed by entering a SAT value other than the one shown (selections are 1 to 3). The mobile was told to expect a specific SAT tone during the last voice channel designation order. If the mobile hears a different SAT, it thinks it has wandered into coverage from another cell, so it first mutes its transmit and receive audio and after 5 seconds, (a fade allowance), it stops transmitting to avoid interfering with the other cell.

To terminate the test from the mobile, either hang up or press the 'END' key on the handset. The R2008D/R2010D will measure the duration of the termination (1.8 sec) 10 KHz signaling tone generated by the mobile.

To terminate the test from the R2008D/R2010D, enter a '1', abort, on the top line of the display.

For a detailed description of the cell initiated sequence test steps, see appendix A and C.

3) SEQUENCE TEST, MOBILE INITIATED

The mobile initiated sequence test is similar to the cell initiated test except the cellular telephone is placing the call. This screen is accessed through the main Signaling Sequence screen. See figure 7.

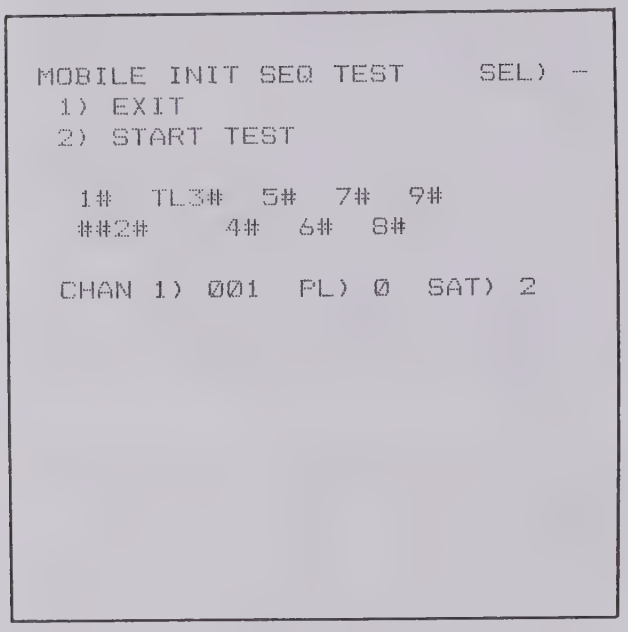


FIGURE 7.
MOBILE INITIATED SEQUENCE TEST DISPLAY

The selections possible are 1) EXIT, and 2) START TEST. These selections are possible if the cursor is in the home position at the top of the screen. A '1' will return the screen back to the tone memory screen. A '2' will start the test.

Help messages describing the blocks of the thermometer sequence can be accessed by moving the cursor to the line underneath the squares and advancing to the right by keying any number 1 to 9. The squares on the top row of the thermometer display indicate actions that will be taken by the R2008D/R2010D during the test. The squares on the next line indicate actions that the mobile takes are perceived by the R2008D/R2010D. Note that the first square is filled in since the R2008D/R2010D commences a FOCC data stream upon entry into the mobile initiated sequence test screen. The cellular telephone should 'lock up' onto the data stream and the 'no svc' light should go out. If a foreign system ID was entered, the 'roam' light will light.

The test can be started at any time. Once commenced, the R2008D/R2010D will wait for a service request from the car phone. Enter the number that is to be called into the cellular telephone. Allow the 'NO SVC' light to go out, then depress the 'SEND' key the R2008D/R2010D will receive this service request message and display the called address on the CRT screen. Verify that the called address matches the one sent. The mobile ID and serial number are also extracted from this message and displayed on the CRT screen. The mobile ID is also used to update the Initial Parameters data. The R2008D/R2010D now sends an initial voice channel designation message. The R2008D/R2010D and the cellular telephone will switch to the first FVC and RVC channel respectively. See Figure 8. Just as in the cell initiated test, voice communications can be verified, temporary exists are allowed to analyze the signal, handoffs are allowed to any one of the four pre-selected forward voice channel be changed to force a telephone drop out. And, as in the cell initiated test, the call can be terminated either by pressing the 'END' key or by entering a '1' (End) on the top line of the display.

For a detailed description of the mobile initiated sequence test steps, see appendix B and D.

FIGURE 8.
MOBILE INITIATED TEST RESULTS SCREEN

4) MANUAL TEST

The manual test mode is accessed by a '4' entry in the 'SEQ SEL' of the Signaling Sequence screen. See figure 10. This mode allows the operator to enter and send any one of the 43 commands to the transceiver unit of the cellular telephone as defined by the AMPS SPEC of May, 1983.

A '3' entry in the Cellular Manual Test Mode accesses the Cellular Manual Test display, which provides test set up information (accessory cable kit part numbers) for the various types of cellular units. See figure 11.

MANUAL TEST MODE CONNECTION.

The manual test mode requires that the R2008D/R2010D seize control of the transceiver unit by making connection directly to the control port on the mobile unit. The printer/junction box cable is connected to the 37 pin "D" connector on the rear panel of the R2008D/R2010D, and to the 50 pin "D" connector on the cellular junction box. The junction box is then connected to the mobile with an adapter cable from either the RPX-4272A, RPX-4273B or RPX-4274B accessory kit. The antenna connector on the mobile can be connected either to an external antenna for monitoring purposes, or to the R2008D/R2010D directly into the RF in/out port or via the variable RF tap for duplex measurements. See figure 9.

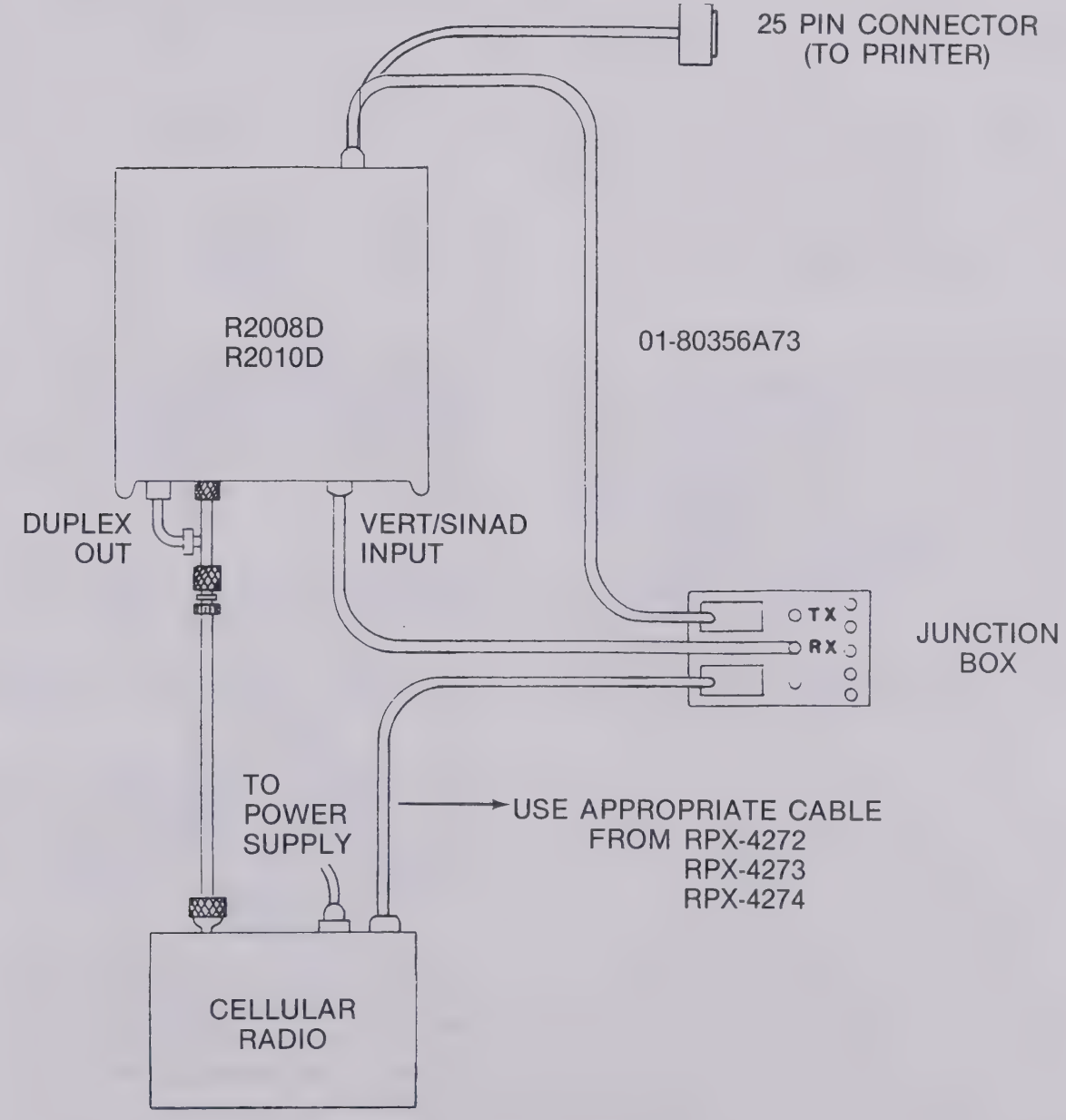


FIGURE 9. MANUAL TEST SETUP

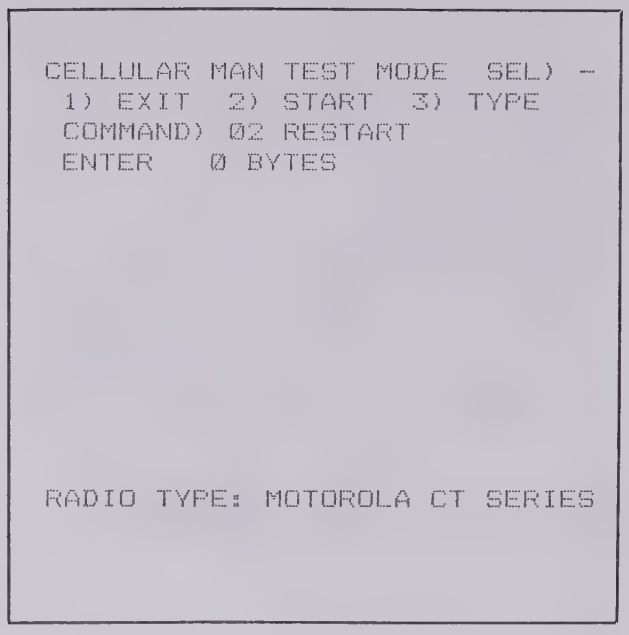


FIGURE 10.
MANUAL TEST MODE DISPLAY

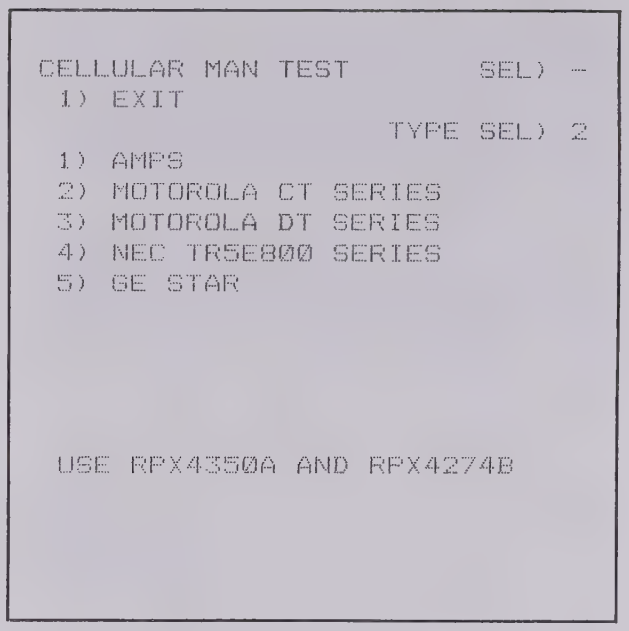


FIGURE 11. MANUAL TEST DISPLAY

Move the cursor down to the command line. Enter the desired command. The R2008D/R2010D will echo back a mnemonic describing the command. If the particular command requested requires additional bytes, dashed lines indicate where they should be entered on the screen. See figure 10. If this is the case, move the cursor over to the dashed lines and make the necessary entries. If hexadecimal data is required, use the normal 0-9 keys, but in addition, use the 'up/down' keys, of DISPLAY, FUNCTION and MODULATION to obtain A-F. The 'up/down' keys of DISPLAY are used for A and B. The 'up/down' keys of FUNCTION are used for C and D. The 'up/down' keys of MODULATION are used for E and F.

To send the command to the transceiver unit, return the cursor to the home position and enter a '2'. The command will then be sent along with any additional bytes required. The operator is now free to send additional commands or to exit the screen and measure parameters using the other R2008D/R2010D test modes.

If the command sent requires that the cellular telephone return information, the R2008D/R2010D will display the returned data automatically.

If failures occur in this handshaking procedure, an error message is displayed on the bottom of the screen.

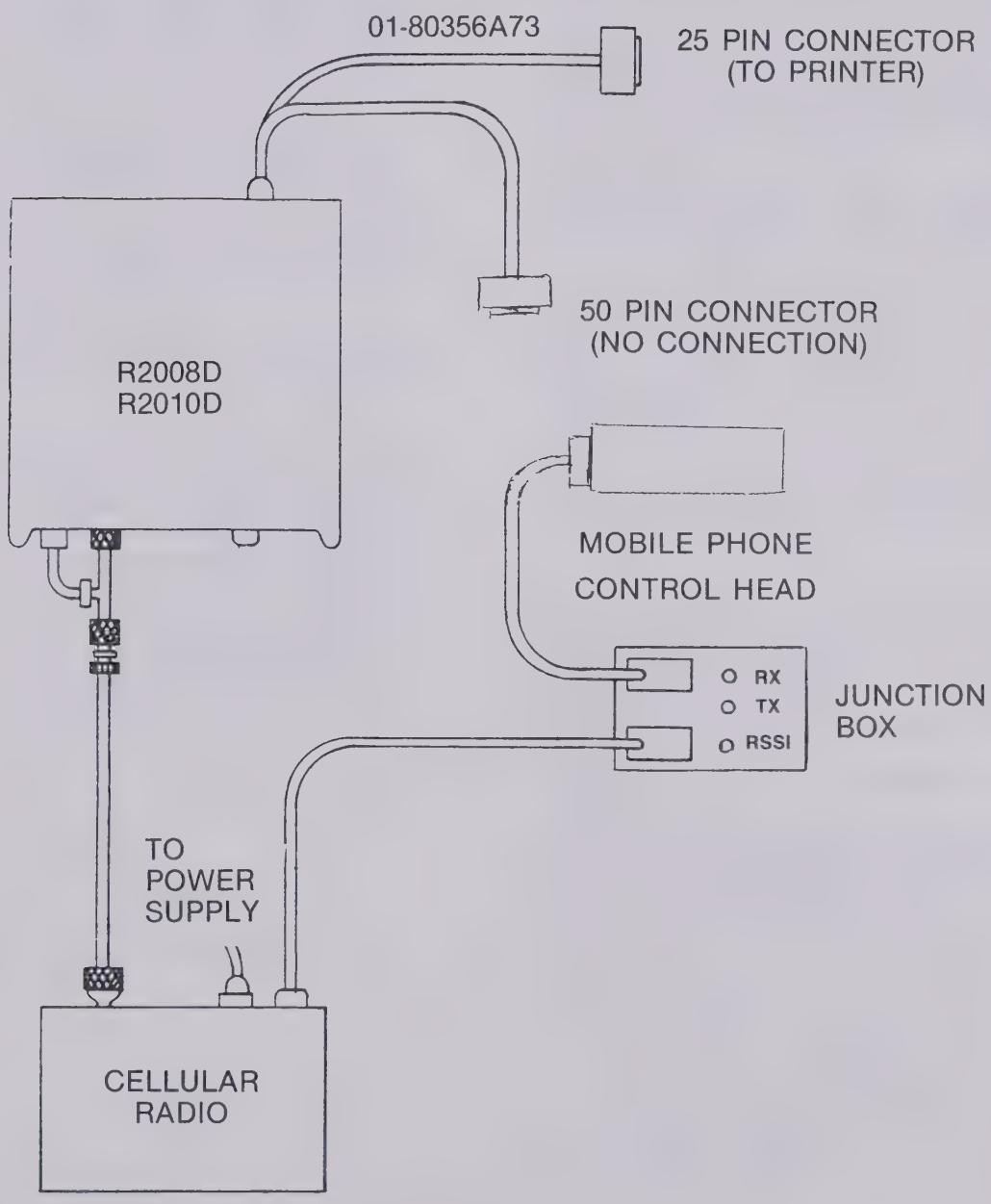
Normally, the first command entered is an 01 command (SUSPEND) to set the transceiver into the test mode so that the other commands can be utilized. Otherwise, only STATUS, TURNAROUND, RESET, RESTART and SUSPEND will function.

Repeats of the same command can be made by multiple entries of '2' while the cursor is in the home position.

For a list of the 43 possible commands, see appendix F.

5) AUTO TEST

The Auto Test Mode enables a technician to test a cellular radio on as many channels as desired. The R2008D/R2010D signals the radio under test as in the sequence tests. Measured values of frequency error, output power and modulation deviation are displayed for each channel tested, and recorded on an optional printer. The following sections describe how to set up and operate the R2008D/R2010D in the Auto Test Mode. See figure 12.



AUTO TEST SETUP

FIGURE 12.

A. INITIAL PARAMETERS

Select the INITIAL PARAMETERS screen by keying a 1 in the main Signaling Sequence screen.

SID Enter the System ID that the mobile expects. If incorrect, or if not known, the mobile will still function but the mobile will give a ROAM indication.

FOCC Enter the FOCC (data channel) desired. The mobile will scan the channels 313-354 as their home system range. Mobiles configured for non-wireline carriers consider channels 313-333 as their home system range.

FVC 1) This channel is the first in the series of channels to be tested. The other three FVC selections are used only in the cell and mobile initiated sequences.

FVC increment This parameter specifies the channel spacing for the automatic handoffs. So if this is 100, then every 100th channel will be checked.

PRINTER (1 = YES, 0 = NO) Select a 1 if a printer is desired, and select 0 if not. The printer is required to have RS232, 1200 baud capability. See Appendix G. for instructions on setting up the optional Epson RX-80 printer, Motorola part no. RT-RX80/8148.

B. AUTO TEST OPERATION

Connect the R2008D/R2010D Mod Out jack to the Tx Audio jack on the junction box.

On the main Signaling Sequence screen, key in selection 5 to access the auto test mode. The screen will instruct the operator to adjust the 1 kHz level too a 2.0 to 2.5 volt output. The purpose of this is to input sufficient signal so the transceiver will begin to go into deviation limiting on each channel tested.

Key in a 2 to begin the test.

A WAIT message will be displayed as the R2008D/R2010D adjusts the 45 MHz offset. At this point, the R2008D/R2010D is sending out an overhead message stream on the FOCC, as a cell would.

This portion of the sequence is very similar to the MOBILE INITIATED test described earlier. The R2008D/R2010D is waiting for a service request message from the mobile under test. The R2008D/R2010D now will display a SEND TEL # WHEN IN SVC message. When the NO SVC indicator on the car phone goes out, start a call from the mobile.

The R2008D/R2010D will now display SAT deviation (not from the 1kHz Mod Out), output power and frequency deviation of the mobile on FVC #1). The R2008D/R2010D will wait for the data to stabilize, and then print it out if a printer was selected. Then, the R2008D/R2010D will issue a release order to the mobile, and resume transmission of overhead data on the FOCC.

After a short delay, to allow the mobile to firmly lock onto the data stream, the R2008D/R2010D will page the mobile using the Mobile ID number sent by the mobile in the earlier part of the test. When the mobile begins to ring, the operator has 10 seconds to answer before the 10 kHz signaling tone interferes with the SAT and deviation measurements.

The R2008D/R2010D will now display frequency error, power output and 1 kHz modulation deviation from the mobile under test.

After a short delay, to allow the data to stabilize, the R2008D/R2010D will execute handoff orders to step the mobile through the FVC range up to channel 666. The R2008D/R2010D will display and send the measured data to the printer for each channel tested.

By looking at trends in the data over the range of channels, a troubleshooter will be able to narrow down the faulty functional blocks in the mobile under test, as well as provide an historical record of the mobile for customer assurance.

5.0 APPLICATION NOTES

A. RECEIVER AUDIO LEVEL TESTING

1) Connect R2008D to transceiver unit via junction box. (Refer to Fig. 13)
2) Disconnect duplex generator output if connected.
3) Select generator function and execute the following manual mode commands:
   01 Suspend
   09 Load synthesizer (enter desired channel)
   12 RX unmute
4) Set R2008D to desired channel (870 MHz plus .03 X channel #) ex. 879.99 MHz equals channel 333.
5) Connect RX audio BNC connector on junction box to Vert/Sinad input on R2008D.
6) Select GEN function on R2010D. Adjust the output level to -50 dBm to simulate a strong signal. Adjust 1 KHz modulation level to 2.9 KHz deviation.
7) With junction box compandor switch in NORMAL mode, adjust radio for 100 mV RX audio while in DVM/DIST display on R2008D. Refer to radio maintenance manual.
8) Increase 1 KHz deviation to 8 KHz, read distortion in either DVM/DIST or GEN/MON display.
9) Data distortion: Using DVM/DIST display, and with modulation still 1 KHz at 8 KHz deviation, measure level at discriminator test point (junction box test point for AMPS bus compliant radios, internal radio test point for others). Using Signaling Sequence display, input 9999.9 Hz for tone A. Turn 1 KHz modulation off. Adjust code synth output for 8 KHz deviation using tone A and note level at radio discriminator. Difference in level from that noted with 1 KHz modulation should be less than 3 dB.
10) Audio frequency response: Bypass the transceiver compandor. Use the Signaling Sequence display to set tone A to 300 Hz, and tone B to 3000 Hz. Using a constant deviation level of 2.9 KHz check the level at the RX audio jack. Typical output levels are:

    300 Hz 331 mV
    1000 Hz 110 mV (REF)
    3000 Hz 33 mV
    AUDIO RESPONSE IS -6 dB/OCTAVE DEEMPHASIS

B. TRANSMITTER DEVIATION

1) Connect R2008D to transceiver unit via the junction box, as in manual test mode connection. (Refer to Fig. 13.)
2) Select power monitor mode and execute the following manual mode commands:
   01 Suspend
   09 Load synthesizer, enter desired channel
   07 Carrier on
   14 TX unmute
3) To check deviation, connect mod out jack to TX audio connector on junction box. Set either 1 KHz level or code synth level using modulation display and observe deviation on GEN/MOD display. Use Signaling Sequence display to vary frequency of tone A or tone B to check deviation on frequencies other than 1 KHz. Send manual mode command 13 TX mute to mute transmitter audio for further tests.
4) Signaling tone deviation can be set by sending the manual mode command 16, Signaling Tone On, to the transceiver unit. Set deviation to 8 KHz measured on GEN/MON display. Manual mode command 17, Signaling Tone Off, will deactivate the transceiver signaling tone generator.
5) DTMF deviation can be set by executing manual mode command 42, DTMF On, and inputting desired digit such as 06. Adjust the transceiver for approximately 8.5-9 KHz deviation (roughly equal to 9 radians peak phase deviation).
6) SAT deviation can be set by executing manual mode command 32, SATON, and entering 01. Set SAT deviation to 2 KHz.

C. RECEIVER SENSITIVITY

1) Connect R2008D to transceiver unit via the junction box. (Refer to Fig. 13.)
2) Execute the following manual commands:
   01 Suspend
   09 Load synthesizer (to desired channel)
   12 Receiver unmute
3) Connect RX audio (on junction box) to R2008D sinad input.
4) Set R2008D to generate on desired frequency (870 + channel # X 0.03 MHz), with 1 KHz modulation at 8 KHz deviation.
5) Bypass the compandor on the transceiver unit.
6) Adjust the RF output level on the R2008D for a 12 dB sinad reading in GEN/MON display.

NOTE: One can expect to see a difference of about 1 dB of RF level between a C-message weighted sinad measurement and a flat weighted sinad measurement on the R2008D, i.e. -115dBm on the R2008D corresponds approximately with -116dBm C-message weighted.

D. POWER LEVEL SETTING

1) Connect R2008D to transceiver unit through the junction box. (Refer to Fig. 13.)
2) Set R2008D to Power Monitor. Through the manual test mode execute the following commands:
   01 Suspend
   09 Load synthesizer (enter desired channel)
   07 Carrier on
   10 Set attenuator (set to 0 highest power)
   NOTE: Power levels are as follows:

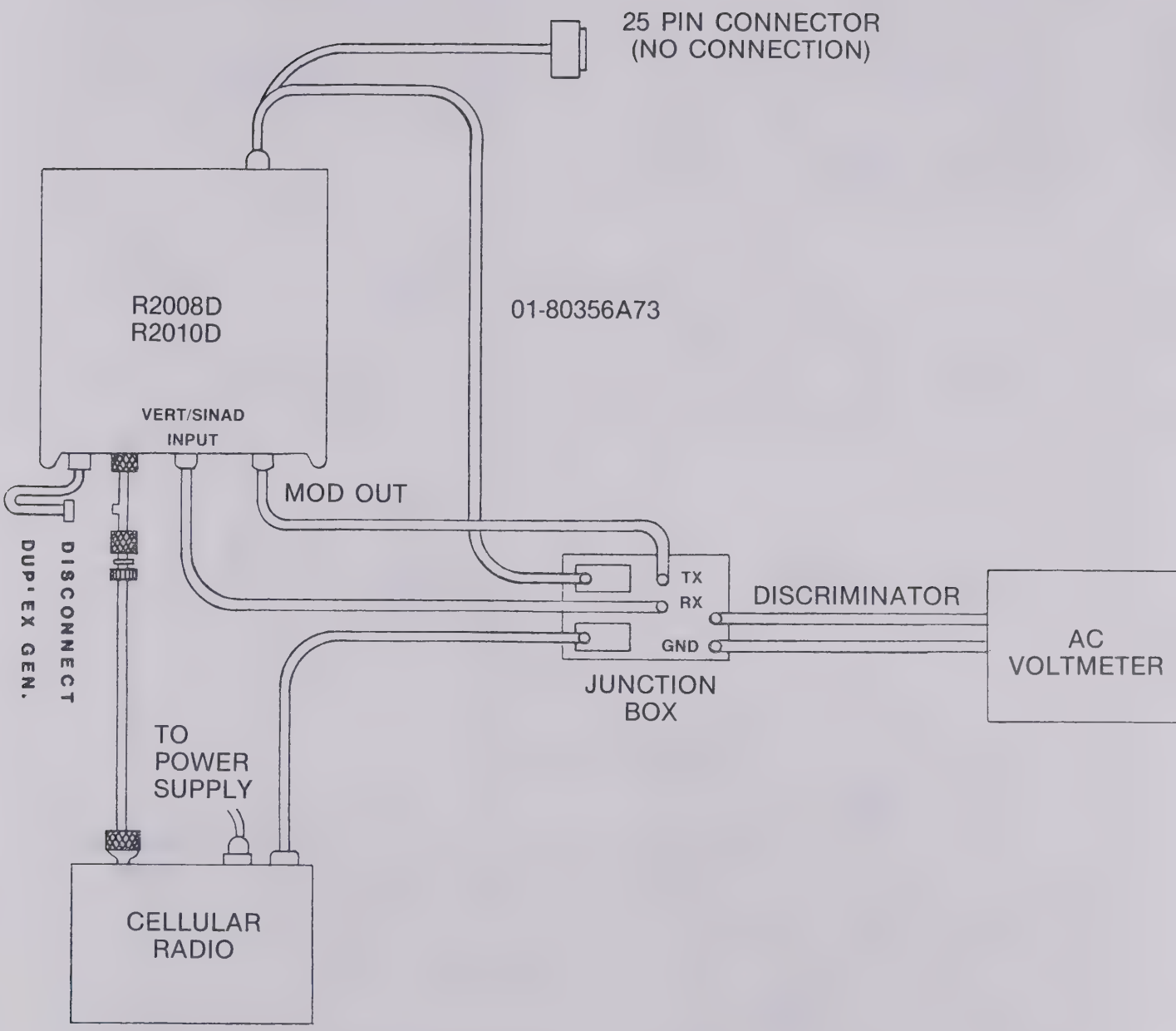
ATTENUATOR	WATTS	dBm
0	3.0	34.8
1	1.2	30.8
2	.48	26.8
3	.19	22.8
4	76mW	18.8
5	30mW	14.8
6	12mW	10.8
7	4.8mW	6.8

3) Note power level in GEN MON display. For the lower power levels, use the R2008D spectrum analyzer.
4) Select the spectrum analyzer display and note the relative power level in dB.
5) In the Signaling Sequence display, execute manual mode command 10, Set Attenuator (select desired attenuation).
6) Determine power level by using the spectrum analyzer display. Note the relative power level in dB. Power output should decrease in 4 dB steps as transceiver attenuator setting is increased through the manual test mode commands.

E. TESTING SIGNALLING AT THRESHOLD LEVEL

It is sometimes desirable to verify the operation of the mobile under weak signal conditions. This can be done by using the following procedure.

1) Connect the R2008D to the transceiver unit via the junction box as in Fig. 13.
2) Turn off the Duplex Generator and disconnect the output from the RF tee.
3) Select the Generator function and execute the following manual mode commands:
   01 Suspend
   09 Load synthesizer (enter the desired channel)
4) Set the R2008D to generate on the desired frequency (870 MHz + 0.03 X channel #), ex. 879.99 MHz = channel 333.
5) Select the DVM display on the R2008D and use a scope or meter probe to access the RSSI test point on the junction box.
6) Set the output level on the R2008D to the desired signaling level. A -108 dBm level is the accepted signaling threshold level. Note the voltage at the RSSI test point.
7) Connect the R2008D to the transceiver unit via the variable RF tee as in the Cell and Mobile Initiated Sequence tests. Reconnect the control head to the transceiver unit.
8) Insert a 60 dB attenuator (part no. 58-80314B21) in series with the Duplex Generator output. Set the variable tap on the RF tee to fully in (maximum coupling).
9) On the Initial Parameters screen, select one of the Forward Voice Channels (FVC) to be the same as the desired FOCC (data channel).
10) Select either the Cell or Mobile Initiated Sequences. Executed the test and handoff to the FVC loaded with the FOCC channel above.
11) Using a temporary exit from the Signaling Sequence screen, select the DVM display. Monitor the RSSI voltage and adjust the tap on the RF tee for the same RSSI voltage noted earlier. The signal being fed to the transceiver unit is now at the desired threshold level.
12) Continue with any of the Cell Initiated, Mobile Initiated or Auto Test sequences to test the performance of the mobile under threshold signaling conditions.

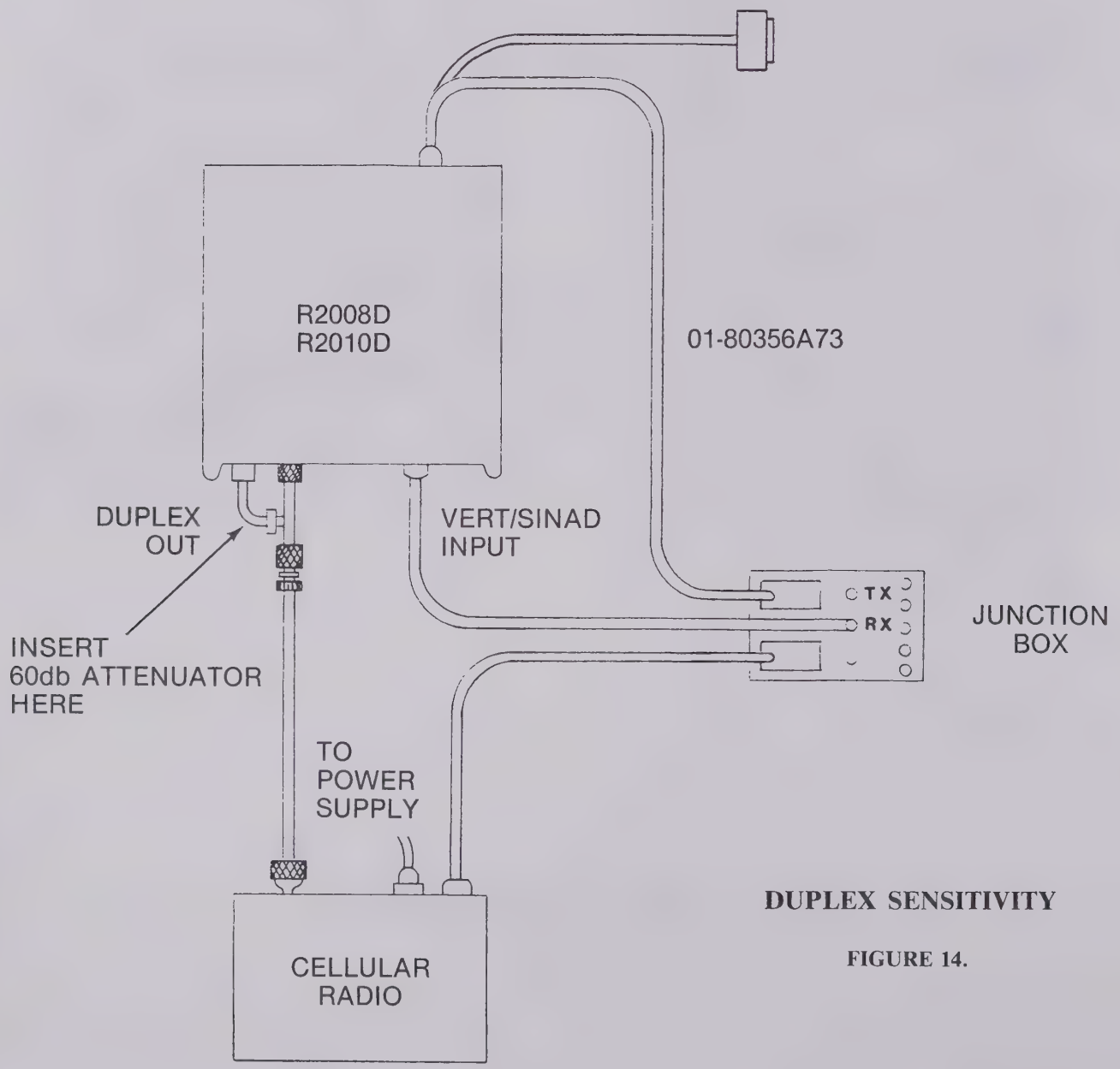


MANUAL MODE, TRANSCEIVER TESTS

FIGURE 13.

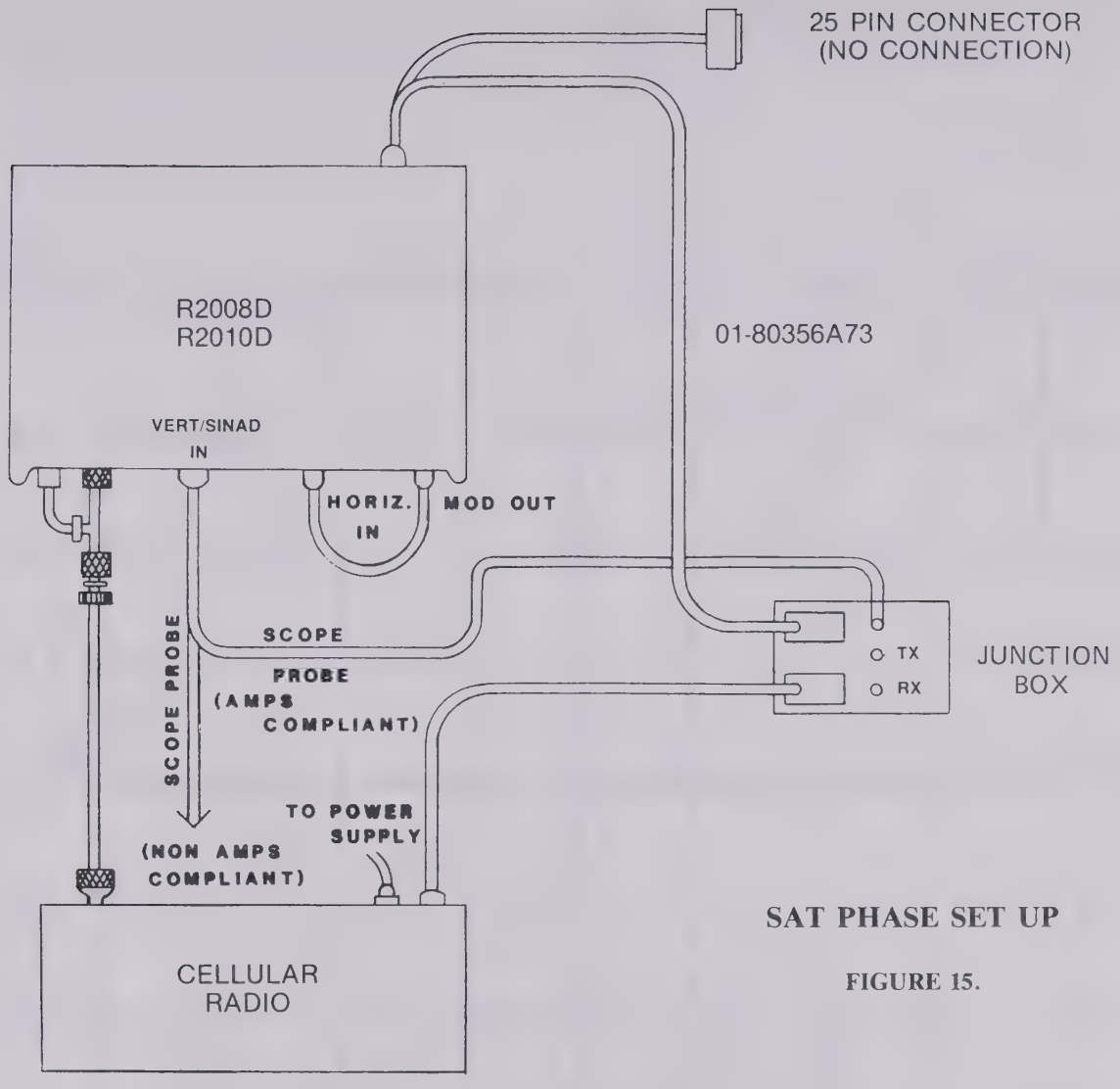
F. DUPLEX SENSITIVITY

1) Connect R2008D to transceiver unit via the junction box. (Refer to Fig. 14.)
2) Connect duplex generator output to variable tap on RF tee through a 60 dB attenuator. (Part No. 58-80314B21)
3) Set: Duplex gen to 45 MHz RF step to -50dB
   IMAGE/DPLX to high
   BW to wide
   Display to duplex gen
   Function to gen
4) Select desired frequency (825 MHz + 0.03 X channel #).
5) Using Duplex Gen display adjust the duplex gen vernier for 45 MHz offset. Adjust 1 KHz modulation for 8 KHz deviation.
   Set function switch to PWR MON.
6) Using manual test mode, send the following commands to the transceiver unit:
   01 Suspend
   09 Load synthesizer (input desired channel #)
   12 Receiver unmute
7) Connect RX audio on junction box to sinad input on R2008D.
8) Using DVM/DIST display, adjust variable tap on RF tee for 12 dB sinad.
9) Using manual test mode, execute command 07, Carrier On, to key the transmitter.
10) Check sinad reading on DVM/DIST screen. Sensitivity will degrade if transceiver has a de-sense problem.



DUPLEX SENSITIVITY

FIGURE 14.



SAT PHASE SET UP

FIGURE 15.

G. SAT PHASE

Lissajous figure method

1) Connect R2008D to transceiver unit via the junction box.

Transceiver	Cable number	
AMPS Complete	01-80356A33	(P/O RPX-4273B)
AMPS Compliant	01-80356A30	(P/O RPX-4272A)
CT Series	RTK-4069B	(P/O RPX-4274B)

(Refer to Fig. 15.)

2) Connect duplex generator to tap on RF tee.
3) Set analyzer to desired channel (825 MHz + .03 X channel #) e.g. channel 333 equals 834.99 MHz
4) Set tone A for 6000 Hz.
5) With display in Duplex Gen position, adjust duplex generator fine frequency vernier to 45 MHz above monitor channel, e.g. channel 333 equals 879.99 MHz. Set function switch to GEN, select code synth mode tone A and adjust code synthesizer level for 2 KHz deviation on Duplex Gen display.
6) Set function switch to power monitor. Using manual mode, execute the following commands:
   01 Suspend
   09 Load synthesizer to desired channel
   07 Carrier on
   32 Saton on SAT 01
7) Using Gen/Mon display, adjust SAT deviation control in radio for 2 KHz deviation.
8) Connect Mod Out to Ext Horiz in with patch cable.
9) Connect Vert In to transceiver modulator test point.
10) Select scope AC display, Ext Horiz input.
11) Adjust horizontal and vertical gain controls until ellipse is just contained in 8cm by 8cm area on CRT, as shown in Fig. 16. Ignore any noise present on the display.
12) Adjust SAT phase shift to make as narrow an ellipse as possible. An ellipse that has Y axis crossings 1.4 CM apart, as shown, represents a system phase shift of 10 degrees. A diagonal line represents a phase shift of 0 degrees.

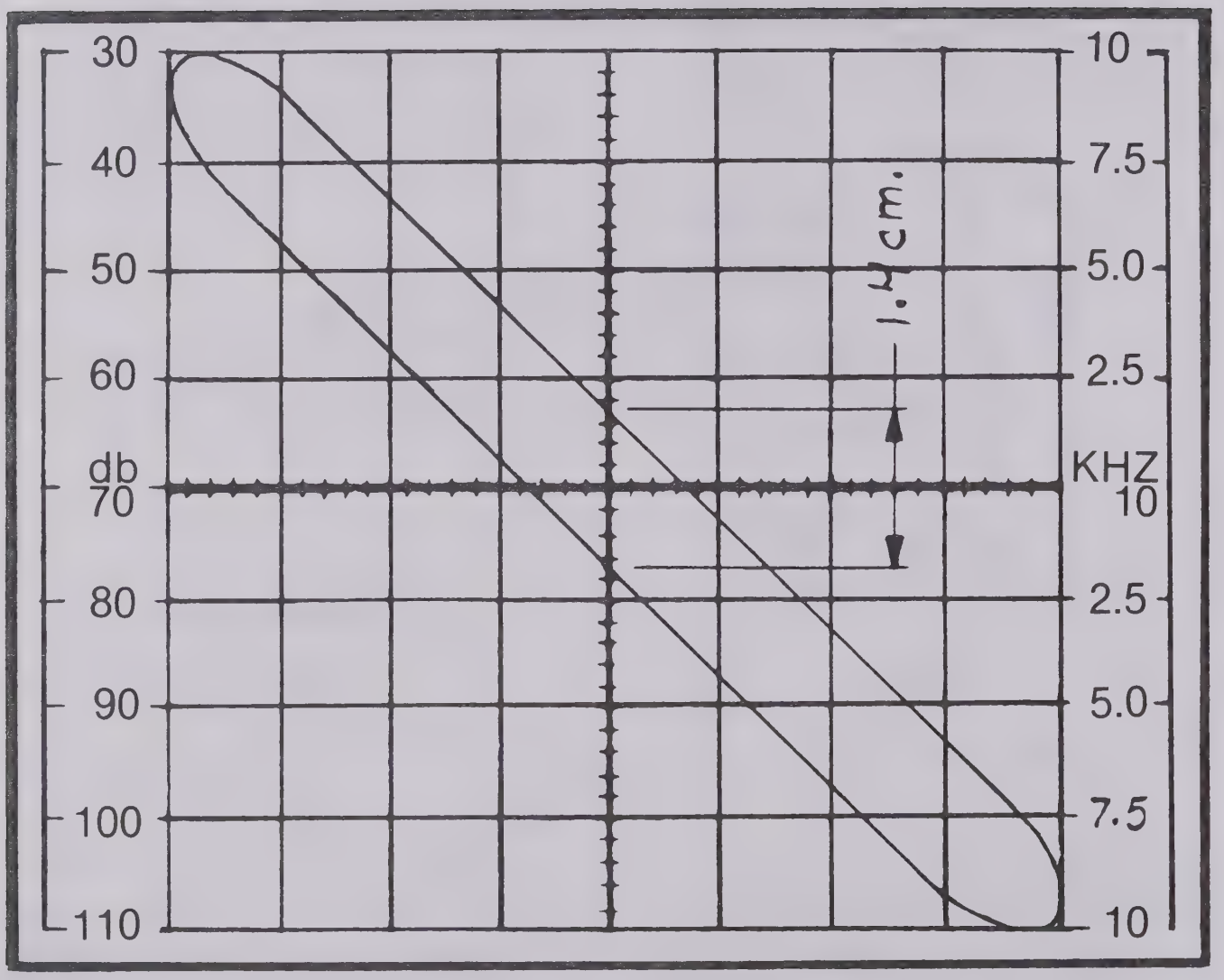
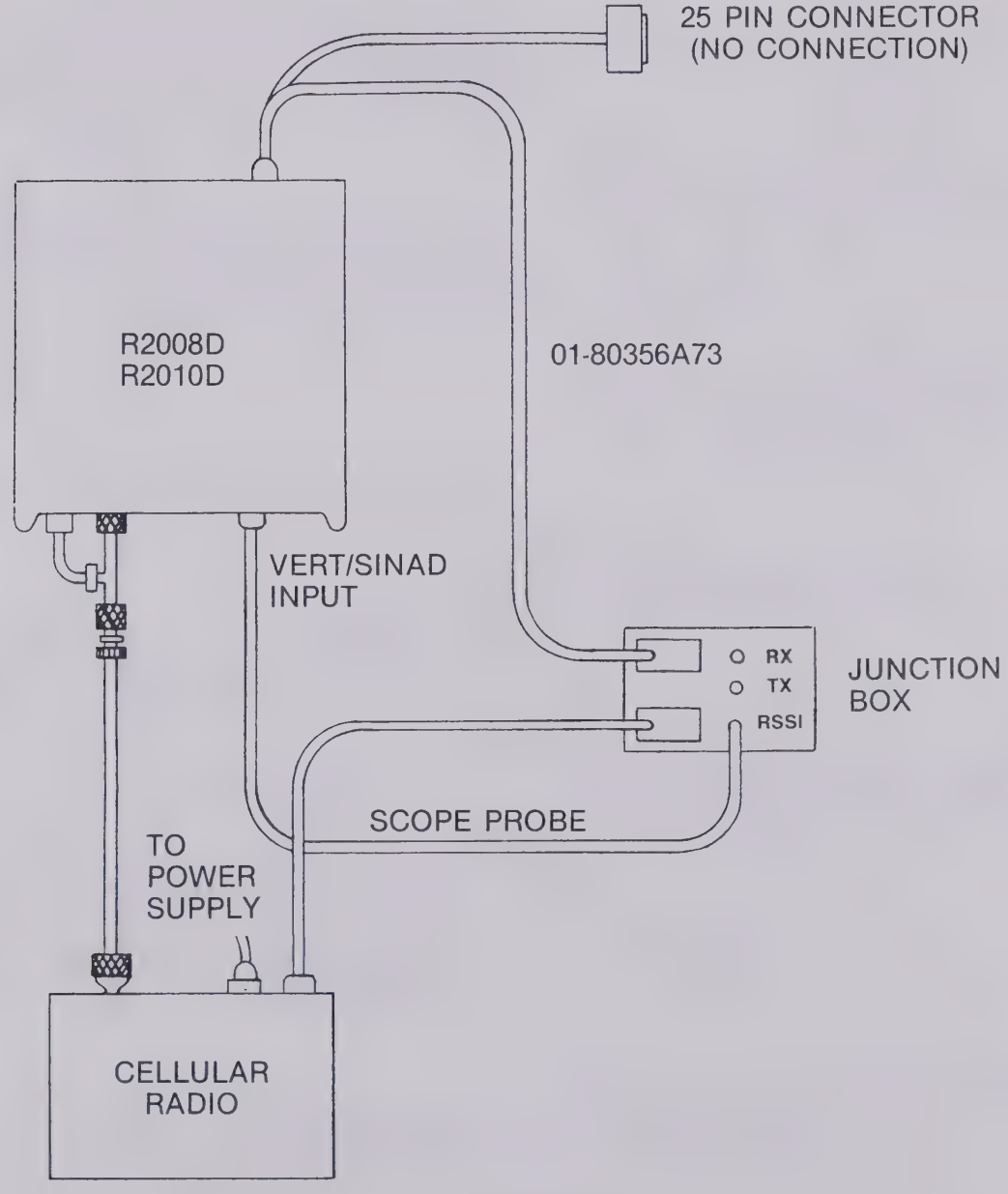


FIGURE 16. SAT PHASE ADJUSTMENT. LISSAJOUS FIGURE SHOWING 10° OF PHASE SHIFT.

H. RSSI TESTING

The cellular mobile uses its RSSI (received signal strength indicator) to determine which FOCC is the strongest one, so it can lock onto the data channel from the nearest cell.

1) Connect the R2008D to the mobile via the junction box. (Refer to Fig. 17.)
2) Using the Manual Test mode, execute the following commands:
   01 Suspend
   09 Load synthesizer (input desired channel)
3) Connect the R2008D RF In/Out port to the mobile, and turn off the Duplex Generator. Select the desired frequency on the display (870 MHz + 0.03 X channel #).
4) Set the R2008D to the DVM screen. Connect the Vert/Sinad input to the RSSI test point on the junction box. Adjust the RF step and vernier controls for the desired output level.
5) The transceiver RSSI voltage should start at from 0 to 0.5 volts with no signal. RSSI should start increasing with a –110 dBm input level and increase steadily up at least –40 dBm input level.

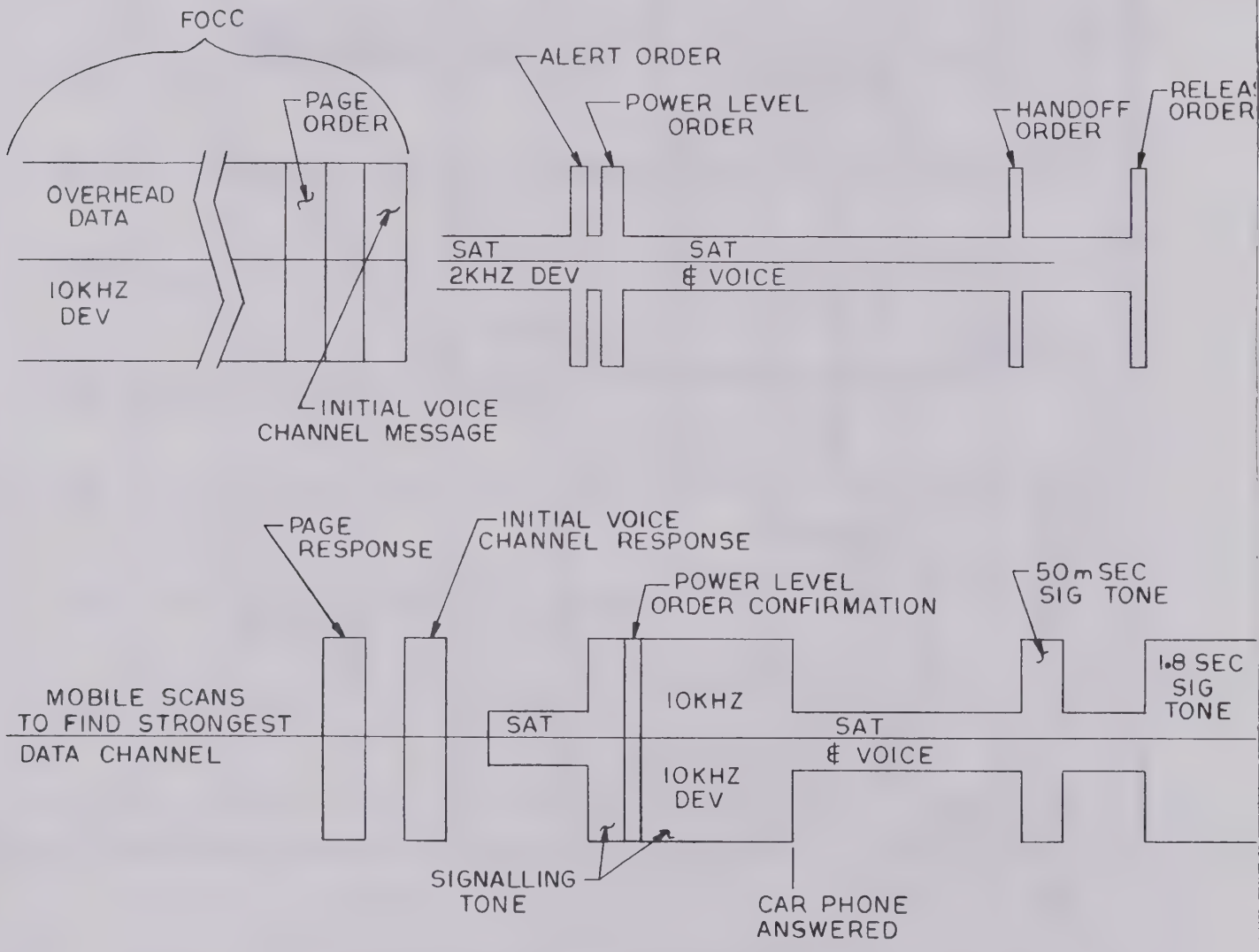


RSSI TESTING

FIGURE 17.

APPENDIX A
CELL INITIATED TEST STEP DEFINITION

The following illustration, figure 18, shows the major events in the Cell Initiated Sequence Test. The top line represents the forward, or from the base, data and SAT sequences. The lower line represents the reverse, or from the mobile, data and SAT exchange. The horizontal time axis is not to scale, this illustration is a conceptual overview of the handshaking that takes place in a cellular system.



CELL INITIATED TEST STEP DIAGRAM

FIGURE 18.

The following list corresponds to the step rectangles seen on the cell initiated sequence test screen, figure 5. The first sentence following each number is the help message that will be seen if the cursor is positioned under that test square on the R2008D/R2010D display.

R2008D/R2010D ACTIVATED

1. FOCC-system parameter overhead messages sent. The R2008D/R2010D sends a continuous stream of system parameter overhead messages to the mobile unit under test.

2. FOCC-paging message sent. The R2008D/R2010D sends a paging message to the mobile unit under test. The paging message contains the mobile telephone number entered in the initial parameters screen.

MOBILE ACTIVATED

3. Page response accepted. The R2008D/R2010D perceives a valid page response from the mobile.

4. Voice channel designation message sent. The R2008D/R2010D sends a message to command the mobile to a forward voice channel.

5. Sat accepted. The mobile and R2008D/R2010D are now on FVC #1. The R2008D/R2010D measures the SAT returned by the mobile to verify that it is the correct SAT.

6. Alert order sent. The R2008D/R2010D sends out an alert order to command the mobile to start ringing.

7. Signaling tone accepted. The R2008D/R2010D detects a valid signaling tone from the mobile verifying that the mobile has been alerted.

8. Power level command sent. A high power level command is sent by the R2008D/R2010D to the mobile.

9. Power level order confirmation accepted. The R2008D/R2010D has received an order confirmation from the mobile.

10. Power level and handoff testing normal conversation mode. The R2008D/R2010D allows for manual power level testing of the other power levels possible from the mobile. Handoffs to the four possible forward voice channels can be made. A SAT drop test can be performed.

11. Release signaling tone accepted. The R2008D/R2010D has received a termination signaling tone.

12. TEST COMPLETED.

APPENDIX B
MOBILE INITIATED TEST STEP DEFINITION

The following corresponds to the test step rectangles seen on the mobile initiated sequence test screen, Figure 7. The first sentence following each number is the help message that will be seen if the cursor is positioned under that test square on the R2008D/R2010D CRT screen.

CELL ACTIVATED

1. FOCC-system parameter overhead messages sent. The R2008D/R2010D sends a continuous stream of system parameter overhead messages to the mobile under test.

TL- Display called address.

3. Voice channel designation message sent. The R2008D/R2010D sends a message to the mobile, instructing it to tune to a forward voice channel.

5. Power level command sent. A high power level command is sent by the R2008D/R2010D to the mobile.

7. Power level and handoff testing, normal conversation mode. The R2008D/R2010D allows for manual power level testing of the other power levels possible from the mobile. Handoffs to the four possible forward voice channels can be made. A SAT drop test can be performed.

9. TEST COMPLETED.

MOBILE ACTIVATED

2. Service request accepted with called address. The R2008D/R2010D accepts the service request message, displays the telephone number, the mobile and serial number from the mobile.

4. SAT accepted. The R2008D/R2010D measures the SAT returned by the mobile and verifies that it is correct.

6. Power level order confirmation accepted. The R2008D/R2010D has received an order confirmation from the mobile.

8. Mobile terminates RVC. The R2008D/R2010D has received a termination tone from the unit under test.

APPENDIX C
DETAILED CELL INITIATED TEST ACTIONS

The following describes in more detail what goes on in a typical cell initiated sequence test. It includes internal functions to the cellular telephone. This is only a brief summary. Refer to the AMPS specification for a more detailed description and to find the definitions of various acronyms used.

R2008D/R2010D	MOBILE
Enter initial parameters through the initial parameters screen of the tone memory mode. SYSTEM ID MOBILE ID FOCC FVC #1 TO #4 FVC INCREMENT (AUTO TEST) PRINTER (YES/NO)	
	Power up mobile. Mobile performs DC power up task.
Enter cell initiated sequence test screen. The R2008D/R2010D starts to send a continuous stream of system parameter overhead messages.	
	Mobile performs initialization task. A. Scan control channels . B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead messages. E. Update overhead information.
	Perform paging channel selection task. A. Scan paging channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead message. E. Perform overhead message processing task.
	Enter idle task examine data for: A. Paging match. B. User request. C. Order. D. Overhead message.
	Receive paging message. Perform page response task. A. Scan access channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Retrieve internal access parameters. E. Wait random delay. F. Seize RECC. G. Perform service request subtask. H. Enter await message subtask.
Accept page response. Extract mobile number and serial number and display on R2008D/R2010D.	
Send initial voice channel designation message.	
Tune to FVC.	

Perform initial voice channel confirmation subtask.
A. Tune receiver to R2008D/R2010D FVC.
B. Adjust transmit frequency to RVC.
C. Adjust rf power to VMAC.
D. Turn on SAT.
E. Set DSCMM to SCC.

Accept transponded SAT as an indication of mobile confirmation.

Enter waiting for order task.

Send alert order.

Receive alert order.
A. Turn on 10 KHZ signaling tone.
B. Generate "ring".

Accept signaling tone (10KHZ) as confirmation of alert order.

Enter waiting for answer task. A Maximum of 65 seconds allowed for answer.

Off hook (mobile is answered). Signaling tone is turned off.

Enter conversation task.
A. Set audio mode to conversation.
B. Two way audio conversation now in progress.

Send power level command. High power.

Adjust power level to that requested and send order confirmation.

Accept order confirmation. Manual power level testing permitted. Select power levels 0-7.

Adjust power level to that requested and send order confirmation.

Verify order confirmation.

Handoff testing permitted. Select FVC.

Send a 50 msec signaling tone as a confirmation. Change to the new RVC.

Confirm 50 msec signaling tone time for the handoff.

Switch to the new FVC.

SAT drop testing permitted. Select a new SAT frequency (1-3).

If a new SAT selected, the mobile should stop transmitting after 5 seconds.

Repeat power level and/or handoffs above as described.

Temporary exists allowed to analyze signals using the other R2008D/R2010D modes.

On - hook (mobile hangs up). Enter release task.
A. Set audio mode to idle.
B. Send signaling tone (10KHZ) for 1.8 seconds.

Receive termination signaling tone. Check for proper duration.

End of cell initiated sequence test.

APPENDIX D
DETAILED MOBILE INITIATED TEST ACTIONS

The following describes in more detail what happens during a mobile initiated sequence test. Refer to the AMPS specification for a more detailed description.

R2008D/R2010D	MOBILE
Enter initial parameters into the R2008D/R2010D if not already done.	
Enter mobile initiated sequence test screen.	
The R2008D/R2010D starts a continuous stream of system parameter overhead messages.	
	Perform initialization task. A. Scan control channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead message. E. Update overhead information.
	Perform paging channel selection task. A. Scan paging channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead message. E. Perform overhead message processing task.
Enter idle task. Examine date for:	
	A. Page match. B. User request. C. Order. D. Overhead message.
	Enter origination task: A. Scan access channels. B. Examine call state. C. Tune to R2008D/R2010D FOCC. D. Acquire word sync. E. Read digital color code (DCC). F. Retrieve access protocol parameters. G. Wait random delay. H. Re-examine call state. I. Seize reverse control channel. (RECC) J. Perform service request subtask. K. Send service request message.
Accept service request message and display called address, mobile number and serial number.	
Send initial voice channel designation message.	
Tune to FVC.	
	Enter initial voice channel confirmation subtask. A. Tune to RVC. B. Adjust rf power to VMAC. C. Turn on SAT transponder. D. Set DSCMM to SCC.

Accept SAT.

Enter conversation task.

Send power level command. High power.

Adjust power level to high and send order confirmation.

Accept order confirmation.

Manual power level testing permitted. Select power level 0-7.

Adjust power level to that requested and send order confirmation.

Handoff testing permitted. Handoffs to FVC #1-4 allowed.

Handoff confirmation is 50 msec signaling tone.

Change to new RVC.

Confirm 50 msec signaling tone for handoff. Switch to new FVC.

SAT drop testing permitted. SAT selections 1-3 allowed.

If a new SAT is selected, the mobile should drop after 5 seconds.

Repeat power level and/or handoffs as desired.

Temporary exits allowed to analyze signals using the other R2008D/R2010D modes.

On-hook (mobile hangs up). Sends 1.8 second signaling tone (10KHZ)

Accept 1.8 second termination signaling tone. Display error if out of limits.

End of mobile initiated sequence test.

APPENDIX E
WARNING AND ERROR MESSAGES

The warnings and errors possible in cellular testing are outlined in the following table.

SUMMARY OF WARNING AND ERROR MESSAGES

WARNINGS

1 Power level order confirmation not accepted.
3 Handoff signaling tone out of limits.
4 Termination signaling tone out of limits.
5 Invalid DTMF keycode. (Manual Test only)
7 Incorrect SAT returned.

ERRORS

4 Channel out of 1-666 limit
11 Page response not valid
12 Page response not received
13 Alert signaling tone not accepted
14 Handoff signaling tone not accepted
18 Service request message sent by mobile in error
19 SAT not returned
20 Too many bytes in free format command
21 Bell command not in 1-43 range
22 Transceiver does not acknowledge command
23 Transceiver's DCL has not gone high
24 Transceiver has not set TCL low
25 Transceiver has not set TCL line high
26 Transceiver not powered up
27 Transceiver did not accept all commands words
28 Transceiver did not send all response words
29 Too many bits in response word
30 Too few bits in response word
31 Transceiver timed out in idle state
32 Transceiver timed out in data state
33 Opcode error
34 No response from transceiver

WARNING 1

Power level order confirmation not accepted. The R2008D/R2010D has sent the cellular telephone a power level command. The telephone's confirmation has not been received or it has been detected as incorrect. Possible causes are low cellular telephone sensitivity, excessive loss in the RF test connections or an attenuation setting that is too high on the R2008D/R2010D.

WARNING 3

Handoff signaling tone out of limits. The R2008D/R2010D has detected that a 10Khz signalling tone sent by the cellular telephone the cellular telephone in response to a handoff message is out of limits. The typical duration is 50 msec. This warning is displayed if the duration is outside a 40-60 msec window.

WARNING 4

Termination signaling tone out of limits. The R2008D/R2010D has detected that the duration of the termination 10 kHz signaling tone is out of limits. The typical duration is 1.8 seconds. This warning is displayed if the duration is outside a 1.7 to 1.9 second window.

WARNING 7

Incorrect SAT returned. The R2008D/R2010D has detected that the SAT transponded back by the cellular telephone is out of limits. The three SAT tones are 5970, 6000 and 6030 Hz. The R2008D/R2010D allows a window of ± 10 Hz around the proper SAT. This warning can be induced if a large amount of background noise is present while initiating a sequence test, while doing handoffs or while performing an auto test sequence.

ERROR 4

Channel out of 001-(1)000 limit. A channel number entered in the initial parameters screen, is outside the 001-(1)000 limit allowed as valid FOCC and FVC's.

ERROR 11

Page response not valid. The page response sent by the cellular telephone is not valid. This error can be induced if the squelch control is set too close to 'breaking' or if the signal from the cellular telephone is attenuated too much due to a problem with the RF cable hookup, the R2008D/R2010D has too much attenuation dialed in on its front panel or if the cellular telephone has a transmitter that is below normal power. This is visually verified by looking at the red Sig Lvl lamp on the R2008D/R2010D front panel and by checking the current drawn by the transceiver unit. Normally, the LED will light once for a split second to indicate the R2008D/R2010D has received a paging reply. If the LED flickers several times over a 2 second period, the cellular telephone is trying to reply but the R2008D/R2010D does not recognize the transmission as a valid page response. If the LED does not light, check to be sure the car telephone is set up and that power is applied properly.

ERROR 12

Page response not received. This error indicates that the cellular telephone is not responding to a page message issued by the R2008D/R2010D. Check the R2008D/R2010D Sig Lvl LED as in error 11 above. Also, if the transceiver unit is transmitting, as verified by increased current draw, the radio may be locked onto spurious signal from the R2008D/R2010D Duplex Generator. If this is suspected, a 60 dB attenuator (part no. 58-80314B21) may be inserted in series with the Duplex Generator output jack.

ERROR 13

Alert signaling tone not accepted. This error indicates that the analyzer did not detect the 10KHz signaling tone from the cellular telephone.

ERROR 14

Handoff Signaling Tone not accepted. The mobile issues a 50 msec burst of signaling tone (10 kHz) in response to a handoff order while in the conversation mode. This error indicates that the R2008D/R2010D detects this tone to be outside a 40 to 60 msec window.

ERROR 18

Service request message invalid. The R2008D/R2010D has received a data packet from the mobile but it is not interpreting the received data as a valid service request message. This can be caused by the squelch breaking prematurely on the R2008D/R2010D, or by noise mixed with the incoming data packet. Make certain that the squelch on the R2008D/R2010D is not 'breaking' on noise. In normal operation, the Sig Lvl LED on the R2008D/R2010D will flash briefly while the R2008D/R2010D difficulties recognizing the service request, the LED will flicker several times during a 2 second interval. Verify good RF cable connections. Check the attenuation setting on tohe R2008D/R2010D (typically set at -50 dB).

ERROR 19

SAT not returned. A supervisory audio tone (SAT), even the wrong SAT, has not been returned by the cellular telephone. This error generally indicates that the cellular telephone has not shifted frequencies correctly as a result of an initial voice channel designation message or a handoff message. This error can be induced if the background ambient noise during a test is excessive.

*NOTE: The following errors are related to the manual test mode. Refer to figure 11 for an example of the STATUS command transfer sequence.

ERROR 20

Too many butes were specified in the manual mode free format (00) command. Only 3 bytes are allowed.

ERROR 21

Manual test command not in 1-43 range. The command entered is not in the 1-43 range of commands allowed by the AMPS spec.

ERROR 22

Transceiver does not acknowledge the command. The transceiver does not acknowledge the command just sent. It can result if the cable between the R2008D/R2010D and the transceiver unit is not making good connection. Also check power connection to the mobile unit. Only 5 of the 43 commands will function before an 01 SUSPEND command is sent. These are: STATUS, TURNAROUND, RESTART, RESET and SUSPEND.

ERROR 23

Transceiver has not set DCL high. This error indicates that a command requiring returned information has been sent, but the direction control line (DCL) has not been set high by the transceiver unit, a necessary condition for the returned data transfer. This line is controlled by the transceiver.

ERROR 24

Transceiver has not set TCL low. This error indicates that a command requiring returned data has been sent, and the direction control line (DCL) has gone high indicating the transceiver understands that it is to return data, however, the test control line (TCL) has not gone low. The TCL must go low to indicate valid data on the manual bus.

ERROR 25

Transceiver has not set TCL high. This error indicates that a command requiring returned information has been sent, and the DCL has gone high indicating the transceiver is to return data, and the TCL has gone low to flag the R2008D/R2010D to read the data from the manual bus, however, the TCL has not gone back high to indicate the R2008D/R2010D has read the manual bus. The transceiver should return the TCL high when it senses that the R2008D/R2010D has lowered the clock line (CL) and has returned it high after reading data from the transceiver on the manual bus.

ERROR 26

Transceiver not powered up. The transceiver unit did not turn on or is not connected to a power source. Check all power connections and Re-Try the command.

ERROR 27

Transceiver did not accept all command words. The transceiver unit did not acknowledge receipt of all data sent by the R2008D/R2010D.

ERROR 28

Transceiver did not send all response words. The transceiver unit did not send all expected data to the R2008D/R2010D.

ERROR 29

Too many bits in response word.

ERROR 30

Too few bits in response word.

ERROR 31

Transceiver timed out in idle state.

ERROR 32

Transceiver timed out in data state.

Error 29, 30, 31, and 32 usually mean that the microprocessor in the transceiver malfunctioned.

ERROR 33

Opcode error-transceiver did not recognize a command word-usually with another error code.

ERROR 34

Transceiver did not transmit any response.

Words to the R2008D/R2010D. Check radio power and cabling connections to eliminate obvious sources of trouble and try again.

APPENDIX F
MANUAL TEST COMMANDS

01 SUSPEND - Terminate the normal mode and enter the test mode. Perform initialization as specified by the INIT command and await further test commands. The autonomous timer shall be reset periodically unless a RESETOFF command received.

02 RESTART - Terminate the test mode, enter the normal mode and restart call processing tasks.

03 STATUS - Return the transceiver unit status to the R2008D/R2010D. Status definitions are:

PL: Power level 0 (highest) - 7 (lowest)
CARR: carrier (1-on)
TN: Signaling tone (1-on)
TXM: Transmit audio mute (1-muted)
RXM: Receive audio mute (1-muted)
WS: Word synchronization (1-ws acquired)
MODE: 1-control channel, 0-voice channel
BI: Current state of majority voted busy/idle (0-busy, 1-idle)
SAT: SAT frequency is encoded as follows:
00 - 5970 HZ
01 - 6000 HZ
10 - 6030 HZ
11 - NO SAT LOCK

04 RESET - Reset the autonomous timer

05 TURNAROUND - echo the byte following the command to the R2008D/R2010D
- requires 1 byte additional data

06 INIT - Initialize the transceiver unit to the following state:
1 - Carrier off
2 - Attenuation - 0 DB
3 - Receive audio muted
4 - Transmit audio muted
5 - Signaling tone off
6 - Autonomous timer reset and its periodic resetting enabled
7 - SAT-OFF
8 - DTMF and audio tones-off

07 CARRIER-ON - Turn the carrier on. Transpond sat only if the SATON command was previously received.

08 CARRIER-OFF - Turn the carrier off.

09 LOAD-SYNTH - Set the synthesizer to the channel specified by the 4 digits following the command: e.g. 0334 sets synthesizer to channel #334.

10 SET-ATTN - Set the RF power attenuation to the value specified in the data byte following the command.

0-7 for lowest to high - attenuation

11 RXMUTE - Mute the receive-audio signal.

12 RXUNMUTE - Unmute the receive-audio signal.

13 TXMUTE - Mute the transmit-audio signal.

14 TXUNMUTE - Unmute the transmit-audio signal.

15 RESETOFF - Discontinue periodic resetting of the autonomous timer (allow timer to time out).

16 STON - Transmit a continuous signaling tone.

17 STOFF - Stop transmission of the signaling tone.

18 SETUP - Transmit a 5-word reverse control channel message. The digital color code shall be 11 and -each of the five words shall consist of the following 48-bit data pattern (repeated 5 times): FF,00,AA,55,CC,33. No channel scan, busy-idle determination, or BCH encoding is to be performed. (There may or may not be forward control channel data present). The transceiver unit shall turn on the carrier at the start of transmission and turn off the carrier at the termination.

19 VOICE - Transmit a 2-word reverse voice channel message. Each of the 2 words shall consist of the same 48-bit data pattern specified for the setup command. The Transceiver unit shall turn on the carrier at the start of transmission and turn off the carrier at the termination.

20 RCVSU - Receive a 2-word forward control channel message, perform majority voting but no error correction and return the 10 bytes of data received to the TS.

21 RCVVC - Receive a 1-word forward voice channel message perform majority voting but no error correction, and return the 5 bytes of data received to the TS.

22 SEND-NAM - Return the information contained in the number assignment module (NAM) to the TS.

- Number assignment module. The number assignment module (NAM) is a separate entity in the mobile equipment that shall store the following information.

- System identification of home mobile service area (SID). The SID is a 15-bit number that is used by the mobile equipment to make the home/roam decision.

- Local use mark. This 1-bit mark is used to make the local control state decision.

- Min mark. This 1-bit mark when set to '1' indicates that home mobile equipment shall send extended address information upon origination and page response.

- Mobile identification number (MIN). The MIN (consisting of MIN1 and MIN2) is a 34-bit number that identifies the mobile equipment.

- Station class mark (SCM). The SCM is a 4-bit number that identifies the type of the mobile equipment.

- Initial paging channels in home MSA (IPCH). The IPCH is an 11-bit number that is the channel number of the first control channel on which the mobile equipment will receive pages when it is in its home MSA.

- Access overload class (ACCOLC). The ACCOLC is a 4-bit number that identifies which overload class field is used to control access by the mobile equipment.

- Preferred system mark. This 1-bit mark when set to '1' identifies that the mobile equipment's preferred system is system A; otherwise, the preferred system is system.

- Group identification mark (GIM). The GIM is a 4-bit number indicating how many bits of the SIDH, starting with the most significant, comprise the group identification.

- Lock combination. This 12-bit number represents the sequence of three decimal digits that is used in unlocking the mobile equipment.

- End-to-end signaling mark. This 1-bit mark when set to '1' indicates that the mobile equipment will have a DTMF keypad while in conversation mode.

- Repertory mark. This 1-bit mark when set to '1' indicates that the mobile equipment is optioned for repertory storage.

- Horn-alert mark. This 1-bit mark when set to '1' indicates that the mobile equipment is optioned for horn-alert.

- Hands-free mark. This 1-bit mark when set to '1' indicates that the mobile equipment is optioned for use with a hands-free control unit.

23 VERSION - Return the software version information to the R2008D/R2010D.

24 SEND-SN - Return the 32-bit serial number to the R2008D/R2010D. Display in hexadecimal.

25 MEM - Return the resident memory data located at the address specified in the 2 bytes following the command. The first and second bytes shall contain, respectively, the most and least significant parts of the 16-bit address.

26 RSVS1 - Receive contiguous 1-word messages on the control channel. Perform majority voting and error correction on each message. Maintain separate counts of the number of uncorrectable and correctable errors detected until a terminate command is received. If the count exceeds 255 (decimal), a count of 255 is to be returned.

27 RCVV1 - Same as RCVS1 except on the voice channel.

28 WSTS - Receive contiguous 1-word messages on the control channel. Maintain a count of the number of word synchronization sequences (11100010010) detected until a terminate command is received. The counter shall be 16 bits wide and the data shall be returned in the following format:

BYTE 1 15 - - - - - - 8
BYTE 2 7 - - - - - - 0

29 WSTV - Same as WSTS except on the voice channel.

30 BIBIT - Receive continiuous forward control channel data, extract and perform majority voting on the busy-idle bits, and respond to status commands, and return the current state of the majority voted busy-idle bit. Reception of an INIT command terminates sequence.

31 TERMINATE - Terminate operation off the previously issued RCVS1, RCVV1, WSTS, or WSTV command and return the data collected to the TS.

32 SATON - Enable the transmission of SAT. The byte of data following the operational code shall contain the color code of the SAT frequency that the transceiver unit may expect to receive (see table below). SAT shall be transmitted if the carrier is currently on or if a subsequent carrier-on command is received.

COLOR CODE VALUE	SAT FREQUENCY
00	5970 HZ
01	6000 HZ
02	6030 HZ

33 SATOFF - Disable the transmission of SAT.

34 CDATA - Transmit continuous 5-word reverse control channel messages. The digital color code shall be 10. Each of the 5 words shall consist of the 48-bit data pattern specified by the 6 bytes of data following the command. The data messages shall be contiguous. Subsequent reception of an init command shall terminate the transmission. The transceiver unit shall turn on the carrier at the start of the transmission.

15 HITNON - Activate the high audio tone (1150 HZ) and apply it to the receive-audio line.

36 HITNOFF - Deactivate the high audio tone.

37 LOTNON - Activate the low audio tone (770 HZ) and apply it to the receive-audio line.

38 LOTNOFF - Deactivate the low audio tone.

39 INVM - Initialize non-volatile memory. Set registration memory and called-address repertory memory to zeros. Set lock state to active (locked).

40 RNVM - Read non-volatile memory and return to TS. The least-significant bit of the first byte transmitted shall contain the lock state, 1-active (locked). The next 80 bytes transmitted shall contain the called-address repertory (10 called-addresses (0-9), 8 bytes each). The first byte transmitted shall contain the two most-significant digits of called-address 9. The next 20 bytes shall contain the registration memory (4 entries of 5 bytes each) in the format shown below. Each group of 5 bytes shall be transmitted with the most-significant byte first.

41 WNVM - Receive 101 bytes from the TS (formatted as in TNVM) and write them to the non-volatile memory.

42 DTMFON - Activate the DTMF generator with the tones associated with the keycode given in the byte following the command. Apply DTMF signals to the modulator and DTMF sidetone to the receive-audio line.

KEY CODES

00-09	CORRESPOND TO 0-9 ON KEYPAD		
10	*	15	AUX ALERT
11	#	16	CLR
12	SEND	17	STORE
13	END	18	RECALL
14	LOCK	19	MUTE

43 DTMFOFF - deactivate the DTMF generator.

APPENDIX G
EPSON RX-80/LX-80 PRINTER SETUP

The optional RT-RX80/8148 printer as shipped by EPSON is configured for parallel operation. To use it with the R2008D/R2010D, the 8148 serial interface card must be installed. Both the main PC board in the printer and the interface card have a series of DIP switches that must be set as follows:

Main Board

DIP SW1	1-1 off	DIP SW2	2-1 on
	1-2 off		2-2 on
	1-3 off		2-3 off
	1-4 off		2-4 off
	1-5 off		
	1-6 on		
	1-7 on		
	1-8 on		

8148 Serial Board

DIP SW1	1-1 off	DIP SW2	2-1 on (off-parallel)
	1-2 off		2-2 on
	1-3 off		2-3 off
	1-4 off		2-4 off
	1-5 on		2-5 off
	1-6 off		2-6 off
	1-7 off		
	1-8 off		

Leave jumpers in factory set position.

Note: If the printer is also to be used as a parallel printer for the R-1801A NAM application, DIP SW2-1 on the 8148 board may be brought out to an external toggle switch. In this case, leave SW2-1 off.

These switch settings correspond to:
1200 baud, no parity, 8 bit word length

APPENDIX H
U.K. CELLULAR SYSTEM ANALYZER (R2010D) DIFFERENCES

Basically, the U.K. (United Kingdom) TACS cellular system is very similar to the U.S. system. The pertinent differences are as follows:

A. Signaling Tone

The R2010D has been modified to accept a signaling tone of 8KHz, at a peak deviation of 6.4 KHz. The U.S. system uses a tone of 10KHz.

B. System Deviation

The TACS system uses the following deviations:

AUDIO: 2-3 KHz at a standard microphone input. See transceiver manual for required input levels.

DATA: 6.4 KHz at an 8KHz rate.

SAT TONES: 1.7 KHz.

SIGNALLING TONES: 6.4 KHz.

C. Channel Frequencies

The TACS system uses 1000 channels at 25 KHz channel spacing. The mobile transmitter frequencies start at 890.0125 MHz (channel 1) and the mobile receiver is 45 MHz higher (channel 1 = 935.0125 MHz). To determine channel frequency, use the following formulas:

TX frequency = (889.9875 + (channel #) x 0.025) MHz
RX frequency = (934.9875 + (channel #) x 0.025) MHz

Enter channels into the R2010D in the format channel #1 = 001, channel #1000 = 000, because the R2010D channel field is only 3 digits. Refer to figure 19.

D. Telephone Number and N.A.M. Protocols

See the transceiver manufacturer's literature for a full discussion of N.A.M. and telephone number formats.

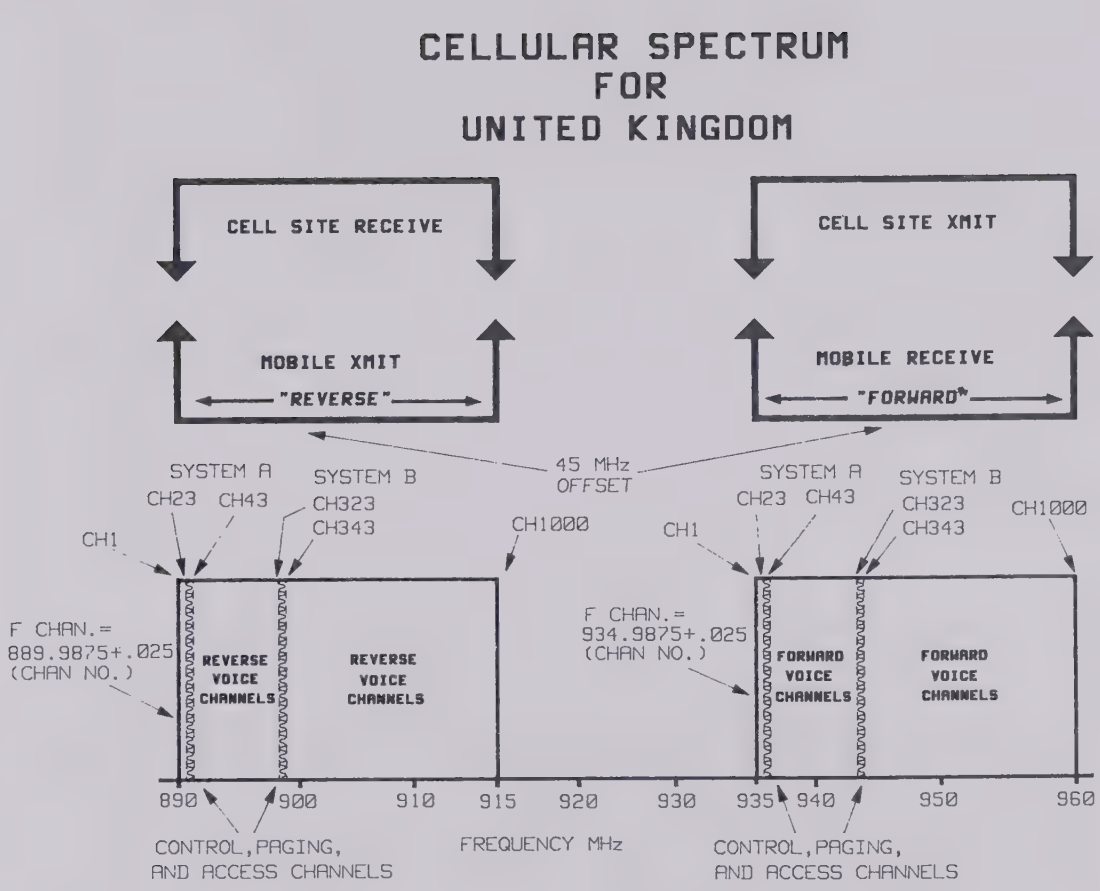

CELLULAR SPECTRUM
FOR
UNITED KINGDOM
CELL SITE RECEIVE
CELL SITE XMIT
MOBILE XMIT
"REVERSE"
MOBILE RECEIVE
"FORWARD"
45 MHz
OFFSET
SYSTEM A
CH23 CH43
SYSTEM B
CH323
CH343
CH1
CH1000
F CHAN.=
889.9875+.025
(CHAN NO.)
REVERSE
VOICE
CHANNELS
REVERSE
VOICE
CHANNELS
F CHAN.=
934.9875+.025
(CHAN NO.)
FORWARD
VOICE
CHANNELS
FORWARD
VOICE
CHANNELS
890
900
910
915
920
930
935
940
950
960
CONTROL, PAGING,
AND ACCESS CHANNELS
FREQUENCY MHz
CONTROL, PAGING,
AND ACCESS CHANNELS

FIGURE 19.

MOTOROLA, INC.
COMMUNICATIONS SECTOR
TEST EQUIPMENT SERVICE CENTER
1313 EAST ALGONQUIN ROAD SCHAUMBURG, ILLINOIS 60196

MOTOROLA, INC.
COMMUNICATIONS SECTOR
TEST EQUIPMENT SERVICE CENTER
2333 B. UTAH AVENUE EL SEGUNDO, CA

TEST EQUIPMENT SERVICE REQUEST FORM

This completed form must accompany equipment returned for service.

CUSTOMER'S PURCHASE ORDER NO.		DATE	
MODEL NUMBER		SERIAL NUMBER	
DESCRIPTION OF PROBLEM:			
REQUESTED SERVICE:			
SHIP TO ADDRESS:			
SHIP VIA:			

Providing the information below will reduce the turnaround time on your Test Equipment Service.

MOTOROLA CUSTOMER NUMBER	BILL TAG	SHIP TAG	INTERNAL MOTOROLA ACCOUNT NO.

SIGNED: _____

OPERATOR'S MANUAL
COMMUNICATIONS SYSTEM ANALYZER

R2008D/R2010D

68P81069A62-0

20083

20083

Manuals Plus Order Sheet

Name _____ Date_____

Company _____

Address 1 _____

Address 2 _____

City_____ State _____ ZIP _____

Bill to same? _____ If No – Put Billing Address in Notes at bottom

Phone _____ Fax _____

Email _____

SKU	MFG	Model	Type	Part #	Price
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

MP MASTER
MA35732

ipping Cost: _____

Payment Info

Card # _____ Exp: mm/yy _____

Name on Card _____ CVV _____

PO Number _____ Order Total: _____

Notes: (such as Billing Address, their Shipping Account Number, etc.)